

*Conservation Assessment*  
*for*  
*Three Birds Orchid (Triphora trianthophora)*



*USDA Forest Service, Eastern Region*

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*This document is undergoing peer review, comments welcome*

*This Conservation Assessment was prepared to compile the published and unpublished information on the subject taxon or community; or this document was prepared by another organization and provides information to serve as a Conservation Assessment for the Eastern Region of the Forest Service. It does not represent a management decision by the U.S. Forest Service. Though the best scientific information available was used and subject experts were consulted in preparation of this document, it is expected that new information will arise. In the spirit of continuous learning and adaptive management, if you have information that will assist in conserving the subject taxon, please contact the Eastern Region of the Forest Service Threatened and Endangered Species Program at 310 Wisconsin Avenue, Suite 580 Milwaukee, Wisconsin 53203.*

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## EXECUTIVE SUMMARY

*Triphora trianthophora* (Swartz) Rydberg (Ochidaceae), three-birds orchid or nodding pogonia, is represented by 24 current occurrences in New England. *Triphora trianthophora* is protected as a threatened (T) or endangered (E) species in Maine (T), Vermont (T), New Hampshire (T), and Massachusetts (E); it is thought to be extirpated in Connecticut. It is a Division 2a plant species according to the *Flora Conservanda: New England* of the New England Plant Conservation Program. There are also several undocumented occurrences in New Hampshire. Recent fieldwork indicates that three of the occurrences may be extirpated, and only ten occurrences had greater than 100 stems at the most recent survey. Current occurrences represent about half of all known current and historic occurrences. The orchid is also rare and threatened in much of its range in North America; it is an S1 or S2 species in 19 of the 30 states in which it occurs and in Ontario.

In New England, the orchid typically occurs in moist hardwood forests dominated by beech in conditions of filtered light. Plants frequently grow in hollows filled with deep leaf litter with few or no other herbaceous plant species co-occurring. *Triphora trianthophora* is thought to depend upon mycorrhizal relationships and to act as a semi-saprophyte. The orchid is ephemeral, with stems appearing above ground and flowering during a short period in late summer. Stems do not appear above ground each year; plants may persist as subterranean tuberoids for extended periods. The long-term persistence of the species likely depends upon the presence of appropriate light, moisture, soil, and leaf litter conditions, as well as conditions that are conducive to the development of mycorrhizal and saprophytic relationships. Development, timber harvest, habitat alteration, and changes that disrupt the orchid's biology or habitat are substantial threats to the taxon. In addition, the small size of many populations makes them vulnerable to stochastic events that may destroy populations, and the cryptic nature of the orchid makes it especially vulnerable to inadvertent disturbance. These threats were contributing factors in the extirpation of historic occurrences and continue to affect extant occurrences.

## INTRODUCTION/OBJECTIVES

*Triphora trianthophora* (Swartz) Rydb. (Orchidaceae) –Three-birds orchid, (also known as Nodding pogonia) – is an elusive orchid occurring in hardwood forests often dominated by beech (*Fagus grandifolia*). In New England, the orchid grows most commonly in hollows filled with deep leaf litter. Few herbaceous species co-occur immediately adjacent to the plant. Moisture conditions are typically mesic, and light conditions are filtered. Although no specific studies exist, numerous investigators assume that *T. trianthophora* depends upon mycorrhizal relationships and is a semi-saprophyte. The orchid is ephemeral; stems appear aboveground and flowering takes place for a brief period in late summer. Pollination is infrequent. Little is known about seed dispersal or seedling establishment. The plant may rely heavily on vegetative reproduction via tuberoids. Plants may exist for numerous years as subterranean tuberoids and produce aboveground stems only at infrequent intervals.

*Triphora trianthophora* ranges widely from Ontario, Canada into New England, south to Florida, as far west as Wisconsin, south to Texas, and into Central America (Luer 1975).

Despite this relatively broad range, *T. trianthophora* is sparsely distributed throughout much of its range in North America. In the United States, the orchid is rare to very rare at the northern edge of its range and becomes more frequent in the south central United States and Appalachian Mountains (Case 1964). According to Natural Heritage Program ranks, the taxon is an S1 species (critically imperiled in a state, typically with five or fewer occurrences or very few remaining individuals) or an S2 species (imperiled in a state, typically with six to 20 occurrences or few remaining individuals) in 19 of the 30 states and in the one Canadian province from which it is currently known (Association for Biodiversity Information 2000). The species receives protection as an endangered or threatened species in 13 states and in Ontario. In New England, *T. trianthophora* is listed in *Flora Conservanda* as a Division 2a species (greater than 20 current occurrences, but with a substantial number with a small number of individuals) (Brumback and Mehrhoff et al. 1996). The taxon occurs in Maine (S1; T), Vermont (S1; T), New Hampshire (S2; T), and Massachusetts (S1; E), and it is believed to be extirpated from Connecticut.

Threats to *Triphora trianthophora* include: development; timber harvest; habitat alteration due to road maintenance; alteration of appropriate light and moisture regimes; disruption of an adequate leaf litter layer and appropriate soil conditions; disruption of mycorrhizal and saprophytic relationships; competition from understory species; changes in canopy composition; stochastic events affecting small populations; low genetic diversity; inadvertent trampling; herbivory; and collection. Several of these threats likely caused the demise of historic occurrences, resulted in suspected extirpation from one New England state (Connecticut), and continue to threaten many extant populations.

A Conservation and Research Plan for *Triphora trianthophora* is necessary to encourage the immediate and long-term persistence of the orchid in New England. Although there are technically 24 current occurrences in New England, Natural Heritage Program data indicate that there may be as few as 20 extant occurrences. Only ten of the current occurrences had greater than 100 stems at the most recent survey. Additionally, there are substantial threats facing the orchid, and the taxon appears to require specific habitat conditions. *Triphora trianthophora* is relatively rare in New England and throughout much of the United States. Additionally, *T. trianthophora* is the only member of the genus found in New England. The species' rarity in New England and throughout the United States, threats to the taxon and its habitat, and its taxonomic uniqueness serve as rationale for developing this New England Plant Conservation Program (NEPCoP) Conservation and Research Plan. The goals of the plan are to compile existing information on the taxon and to provide a framework for long-term conservation of *T. trianthophora* in New England. This two-parted plan provides background information on the taxonomy, biology, ecology, distribution, and status of *T. trianthophora* in the first section. The second section uses this information to develop conservation objectives, general conservation actions for the taxon, recommended conservation actions for each occurrence, and a prioritized implementation schedule for the actions.

The conservation objectives of this Conservation and Research Plan are to:

1. Maintain, at a minimum, the existing occurrences at their current population levels;
2. Search for previously undocumented occurrences and protect any newly found populations when possible;
3. Identify and protect promising habitat that could support the orchid

4. Evaluate the possibility of augmentation, introduction, and reintroduction of the orchid.

Conservation actions that must be taken to meet these conservation objectives include: land acquisition or protection; regular surveys of occurrences; *de novo* searches for new populations; species biology research; habitat management; *ex-situ* activities; evaluation of reintroduction; and education.

## NOMENCLATURE AND TAXONOMY

*Triphora trianthophora* (Swartz) Rydberg is one of 10 species in the genus *Triphora* worldwide (Medley 1996). The genus has long posed taxonomic challenges, but Dressler (1986) places the genus within the Tribe Triphorae in the subfamily Epidendroideae. The Tribe Triphorae is likely a relic group with no very close allies (Dressler 1981). The genus is tropical in origin, with species found primarily in Central America and South America. *Triphora trianthophora* is the only member of the genus found in New England, and it is the only species found north of subtropical southern Florida (Homoya 1993). Two subspecies are recognized: *Triphora trianthophora* subsp. *trianthophora* and *Triphora trianthophora* subsp. *mexicana* (Medley 1991). Subspecies *mexicana* does not occur in the United States (Brown 1997). Throughout this document, *Triphora trianthophora* subsp. *trianthophora* will be referred to as *Triphora trianthophora*. A specimen with erect capsules was designated as the variety *schaffneri* Camp (Camp 1940). However, this is not a genuine variety; erect capsules eventually develop on all stems producing fruits (Homoya 1993), and it is considered a synonym by Kartesz and Kartesz (1980). An albino form, forma *albidoflava* Keenan, has been described from one locality in New Hampshire (Keenan 1992).

Luer (1975) provides a comprehensive overview of the synonymy of *T. trianthophora*. The orchid was originally described as *Arethusa trianthophoros* Swartz in 1800. Subsequent taxonomic revisions were: *Arethusa parviflora* Michaux in 1803; *Arethusa pendula* Muhlenberg ex Willdenow in 1805; *Triphora pendula* (Muhlenberg ex Willdenow) Nuttall in 1818; *Pogonia pendula* (Muhlenberg ex Willdenow) Lindley in 1825; *Pogonia trianthophorus* (Swartz) Britton, Sterns & Poggenberg in 1888; and the current specific epithet, *Triphora trianthophora* (Swartz) Rydberg in 1901. The genus *Triphora* differs from the genus *Pogonia* in column morphology, features of the pollinia, and by producing stolons, which *Pogonia* does not (Homoya 1993). In a systematic study of 210 orchid genera, the genus *Triphora*, along with *Goodyera* and *Elythranthera*, exhibited endothelial cell thickenings in anthers (a useful taxonomic character) that were intermediate between the recognized types characteristic of other orchid genera (Freudenstein 1991). Based on an examination of the literature, Brackley (1985) indicates that *T. trianthophora* has a diploid chromosome number of  $2n=18$ . However, Dressler (1981) states that members of the Tribe Triphorae have 44 rather small chromosomes.

## DESCRIPTION OF SPECIES

*Triphora trianthophora*, a species within the Orchidaceae, is an herbaceous perennial plant of moist woods. The fleshy, delicate stems are glabrous and range in height from 5-30 cm with 3-5 alternate, ovate leaves (1-2 cm in length) that clasp the stem. Shortly before blooming, the stems arise from elongate tuberosities attached to short, slender

stolons; tuberoids produce stems sporadically from year to year. The stems are nodding as they emerge, and straighten as they grow. Each stem typically produces from one to three small (1.5-2 cm), axillary flowers in a raceme; each of the white to pinkish flowers is fully open and fresh for a single day. A stem usually produces a single mature flower on a given day, and blooming tends to be synchronous with most stems in a population producing a mature flower on a given day. The sepals and lateral petals are free, ascending, and similar in appearance; the labellum (lip) is obovate and three-lobed with three small, longitudinal green ridges. An ovate bract subtends each flower. The anther is erect at the end of the column and has two pollinia. The anther has red-purple flanges, and the pollen is purple. When a fruit is produced, the capsule contains thousands of minute seeds. Description of *T. trianthophora* is based on information from Fernald (1950), Martin (1983), Gleason and Cronquist (1991), Homoya (1993), Williams (1994), Brown (1997), MDCNAD (1999).

## **SPECIES BIOLOGY**

*Triphora trianthophora* appears aboveground from fleshy, belowground structures, referred to most accurately as tuberoids (Williams 1994), for a short period in late summer during flowering and into the fall if a fruit develops. In addition to its ephemeral aboveground existence of approximately one month from flowering to fruiting within a year, substantial fluctuations in aboveground population size occur from year to year (Williams 1994). Periodic dormancy may result in a site containing hundreds of aboveground stems in some years and few or no stems in other years (Porcher 1977, Keenan 1986, Homoya 1993, Williams 1994). During an intensive six-year study of 25 sites at one Massachusetts population, total population size fluctuated from approximately 50 plants to 300 plants (Williams 1994). In addition, tuberoids were located in the litter in potential sites where plants had never been observed before, and, subsequently, plants appeared aboveground. Sporadic shoot production makes accurate assessment of population size extremely difficult (Williams 1994).

Individuals within a population may persist for years underground as tuberoids. In fact, most plants appear not to produce a shoot in any given year and instead remain underground (Williams 1994). One occurrence in a well-botanized location in South Carolina was last observed in about 1850 and then seen again in 1975; this rediscovery may be the result of the successful subterranean existence of the orchid via its tuberoids (Porcher 1977). These tuberoids are thickened underground storage structures resembling tubers, but with structural differences (Williams 1994); true tubers do not exist within the Orchidaceae (Dressler 1981). The primary tuberoid contains the apical bud that has the ability to form a new shoot each year. Axillary buds form secondary tuberoids at the end of slender stolons (Williams 1994). The species reproduces asexually by the production of new, secondary tuberoids arising from the plant's primary tuberoid. The secondary tuberoids can separate from the primary tuberoid and produce new, independent stems. Stolons are fragile and near the litter surface and are likely to break as a result of physical forces (Williams 1994). The longevity of colonies of the orchid is not known, but Case (1987) reports a colony in Michigan that has persisted for a minimum of 30 years, and Keenan (1998) notes that one colony in New Hampshire has persisted for at least 70 years.

Flowering in *Triphora trianthophora* occurs from late July until mid-September throughout the United States (Homoya 1993), and typically in August in New England (Brown 1997). There is general consensus that each flower remains open and viable for pollination for a single day (Keenan 1986, Homoya 1993, Williams 1994.). Lownes (1920), however, suggests that blossoms last for three or four days if not fertilized. As with many orchids, pollination does not appear to occur frequently. Each plant tends to have one flower open at a time in synchrony with other plants in the population (Homoya 1993). According to Luer (1975), all mature buds open simultaneously on a given day. The order of opening appears to be erratic, with the top, middle, or bottom buds opening in any order (Keenan 1990). A drop in night-time temperatures often precipitates mass flowering in a population approximately two days later; however, flowering may occur without a drop in night-time temperatures (Luer 1975). Because of synchronous flowering, a single day of flowering for each flower, and the relatively small number of buds per stem, there may be only a few days of mass flowering during the approximately month-long blooming period (Keenan 1998). Triggers for flowering in *T. trianthophora* are likely complex and may involve thermoperiodicity (Luer 1975). A six-year study at a Massachusetts site revealed that the majority of stems produce either one or two flowers, less than 10% of the stems produce no flowers or three flowers, and about 1% of the stems produce four flowers. There is a significant positive relationship between primary tuberoid size and flowering in *T. trianthophora*. At a Massachusetts site, tuberoids producing flowering stems ranged from about 0.4 cm to 2.8 cm; tuberoids producing stems with no flowers, hyaline stems (underground stems), or no stems at all were significantly shorter than those tuberoids producing flowering stems (Williams 1994). Although the relationship between primary tuberoid size and flowering is potentially useful in understanding patterns of aboveground stem density and in conservation efforts, Williams (1994) restricted the examination of tuberoids due to the likely detrimental effects of such disturbance on plants.

Little is known about potential pollinators of *Triphora trianthophora* (Williams 1994). Lownes (1920) identified the bee *Halictus quadrimaculatus* as a pollinator of the orchid. Floral visitors were observed on only two occasions in six years at a Massachusetts site. One visitor was likely a small species of bumblebee (*Bombus*) that entered the flower and exited with a pollinium attached. The other visitor was a smaller bee possibly of the genus *Hylaeus*; pollinium removal did not occur in this visit (Williams 1994). Low pollination levels are likely partially the result of the short duration (one day) of floral longevity (Williams 1994). However, the gregarious flowering habit within a population may increase the likelihood of pollination (Luer 1975).

When pollination and fertilization do occur, capsule development and seed dispersal occur within approximately one month (Keenan 1998). Capsule production, as a percentage of bud production, was less than five percent in each of five years at a site in Massachusetts. Maturation of capsules was 95%; those capsules that did not mature were lost to herbivory (Williams 1994). The minute seeds are likely wind-dispersed; however, no published information is available on patterns of seed dispersal for the orchid. Dressler (1981) notes that most orchids have seeds well suited for wind dispersal. While the majority of seeds are likely to fall close to the parent plant, some seeds may occasionally be dispersed over long distances. *Triphora trianthophora* has typical tiny, dustlike seeds that could be wind dispersed. Although there is no published information available on seedling establishment, it does not seem likely that seedling establishment

rates are high. For any orchid, seeds must be dispersed to locations with appropriate physical conditions and then encounter appropriate fungi to form mycorrhizae (Dressler 1981). Because pollination, seed production, and seedling establishment do not appear to occur frequently, asexual reproduction via secondary tuberoids is likely to be the primary means of reproduction in *T. trianthophora*. Emphasis on vegetative reproduction rather than sexual reproduction may result in decreased genetic variability in *T. trianthophora* (Williams 1994).

Mycorrhizal associations are likely important in various phases of the lifecycle of *Triphora trianthophora* and may enable the plant to act as a saprophyte (Keenan 1986, Homoya 1993, Williams 1994), although there are no known published studies documenting this aspect of its biology. Dressler (1981) indicates that all orchids typically have a saprophytic stage during seedling development. The largely subterranean existence of *T. triphora* and its small photosynthetic surface during its brief aboveground appearance suggest that non-photosynthetic sources of carbon are critical to the species. For this reason, Case (1964) refers to *T. trianthophora* as a semi-saprophyte. Williams (1994) provides an integrated view of several aspects of the life history, biology, and habitat of *T. trianthophora*. She notes that the orchid initiates shoot growth and flowers in the late summer under a full canopy characterized by low light levels, high soil temperatures, and low nutrient and water availability. Unlike spring ephemerals in the deciduous forest that grow and reproduce primarily prior to canopy closure, shade-tolerant species such as *T. trianthophora* carry out most growth under a closed canopy. The plant may be successful in this seasonally stressful environment in part because its mycorrhizal associations may enable it to meet its energy and nutrient requirements. Its reduced leaves may indicate diminished photosynthetic capacity, and much of its existence is spent underground. *Triphora trianthophora* is closely associated with *Fagus grandifolia*, and the orchid may be receiving nutrients and photosynthates from beech trees via mycorrhizal fungi connected both to the beech tree and the orchid. Williams (1994) cites several examples of three-way associations among orchids, mycorrhizal fungi, and adjacent trees. Several associated species are saprophytic or parasitic as well: *Epifagus virginiana*, *Corallorhiza maculata*, and *Monotropa uniflora*.

Herbivory by slugs, insects, rodents, and deer can completely destroy aboveground portions of the plant (Keenan 1986, Williams 1994). Entire plants are consumed occasionally by chipmunks; their tunnels occur under former clumps of *Triphora*, with no trace of stems or tuberoids remaining. Slugs chew through stems and sometimes consume buds and also occur on the tuberoids. The impact of herbivory on a population level is unknown.

## **HABITAT**

In New England, *Triphora trianthophora* grows most commonly in moist, beech-dominated woods in hollows filled with substantial leaf litter. The species occurs in mixed northern hardwood forests and central New England mesic transitional forests. Williams (1994) contends that *Triphora trianthophora* is always associated with *Fagus grandifolia* in New England. There are typically few or no co-occurring herbaceous species growing immediately adjacent to the plants. Elevation at extant New England sites typically ranges from approximately 200 to 900 feet (61-274 meters); three sites occur from 1250 to 1420 feet (381-433 meters) in elevation. Soil is usually acidic at New

England sites, but can be calcareous. The species is noted from rich woods in some regions of the United States. Light conditions are typically filtered. Appropriate light, moisture, soil temperature, and mycorrhizal and saprophytic relationships are likely to be especially critical to the persistence of the species.

Elsewhere in the United States, *Triphora trianthophora* occurs from sea level in Florida to 6,000 feet (1829 meters) in North Carolina. It grows on rich humus in moist woods; it can be found on decaying logs, along streams, in floodplain forests, and on steep mountain slopes (Porcher 1977). In South Carolina, *T. trianthophora* occurs in the coastal plain in mixed mesophytic hardwood forests, where dominant tree species include *Fagus grandifolia*, *Liriodendron tulipifera*, *Quercus alba*, *Q. falcata*, *Q. michauxii*, *Liquidambar styraciflua*, and *Carpinus caroliniana*. Co-occurring herbaceous species include *Corallorhiza wisteriana*, *C. odontorhiza*, *Goodyera pubescens*, *Sanguinaria canadensis*, *Asarum canadense*, *Podophyllum peltatum*, *Obolaria virginiana*, *Amsonia tabernaemontana* var. *salicifolia*, *Thaspium barbinode*, *Thalictrum thalictroides*, and *Uvularia perfoliata*. In Indiana, *T. trianthophora* grows in rich mesophytic woodlands with dominants such as *Fagus grandifolia*, *Quercus rubra*, *Liriodendron tulipifera*, *Acer saccharum*, and *Juglans nigra*. Co-occurring herbaceous species include *Actaea alba*, *Amphicarpaea bracteata*, *Brachyelytrum erectum*, *Carex hirtifolia*, *Desmodium nudiflorum*, *Dryopteris marginalis*, *Epifagus virginiana*, *Galium triflorum*, *Hydrophyllum appendiculatum*, *Osmorhiza pumila*, *Podophyllum peltatum*, and *Polystichum acrostichoides*. Soils typically have a high organic matter content, and adequate moisture and shade are necessary. The species tends to occur on gentle slopes. However, plants grow also in mesic floodplain forests, borders of swamps, and one colony grows on a bare, sandy flat in a wooded ravine (Sheviak 1974, Homoya 1993). In the western Great Lakes region, the orchid grows in *Fagus grandifolia* and *Acer saccharum* woodlands or mixed deciduous forests in pockets of deep humus. The orchid is never found on predominantly mineral soil. It is occasionally reported from sphagnum bogs or mixed forest borders of bogs (Case 1964).

## POTENTIAL THREATS AND MONITORING

There are a number of threats identified in Natural Heritage Program data bases that confront *Triphora trianthophora* in New England. Threats to the taxon include: development; timber harvest; habitat alteration due to road maintenance; alteration of appropriate light and moisture regimes; disruption of an adequate leaf litter layer; disruption of mycorrhizal and saprophytic relationships; competition from understory species; changes in canopy composition; stochastic events that may eliminate small populations; low genetic diversity as a result of small populations and vegetative reproduction; inadvertent trampling; herbivory; and collection. Some of these threats are largely self-explanatory, while others require elaboration. Additionally, while adverse impacts of a number of threats have been suggested, lack of biological information about the taxon and lack of experimental data make it difficult to confirm the severity and prevalence of several of these threats. An evaluation of the importance of each of the threats would require both an understanding of how severe an impact the threat would have and how likely it is that the threat will occur. In terms of severity of impact, it is likely that development, timber harvest, alteration of physical and biological aspects of the habitat, and stochastic events affecting small populations are the most serious threats. Development, timber harvest (and its attendant impacts), small population size, and

changes in canopy and understory composition are present at five or more occurrences each. The following section elaborates further on each threat. The threats discussed below are often interrelated and some may be thought of as primary causes which then have secondary impacts that can affect the orchids; for purposes of thoroughness, however, each is described individually.

- **Development** has eliminated a number of *T. trianthophora* occurrences and continues to threaten several extant sites. Many of the extant occurrences are in sites attractive for development.
- **Timber harvest** may damage or destroy individual plants or colonies, alter light and moisture regimes, and alter important soil characteristics. Most of the large and extensive *T. trianthophora* populations are in relatively undisturbed woods with mature beech. Conversely, it has been suggested that selective harvesting at appropriate times of the year and logging in general may benefit the species by allowing more light to reach the plants. Plants may respond favorably to canopy openings in the short-term. Although the orchid is relatively shade tolerant, it is not typically found in full shade. The orchid seems to have survived logging historically. The interactions between timber harvest, changes in light availability, changes in leaf litter and soil characteristics, growth of a dense understory, and the long-term well-being of *T. trianthophora* are undoubtedly highly complex. Therefore, timber harvest should generally be viewed as a threat unless there is long-term evidence to the contrary.
- **Habitat alteration due to road maintenance** may adversely impact populations through culvert maintenance, plowing and sanding, roadside cutting, and general maintenance.
- **Alteration of appropriate light and moisture regimes** may occur through timber harvest, as mentioned above, development, or a number of other activities. Precise physical requirements are not known, so it is difficult to establish guidelines for various activities that may affect light and moisture.
- **Disruption of an adequate leaf litter layer and appropriate soil conditions** may be highly detrimental to the species; the plant is almost always found in relatively deep leaf litter.
- **Disruption of mycorrhizal and saprophytic relationships** that are likely crucial in the lifecycle of the taxon could eliminate populations.
- **Competition from other understory plants** may result in the decline and extirpation of *Triphora* populations. The taxon tends to occur with very few other species immediately adjacent, and any factor that increases the density of the understory may adversely affect the taxon.
- **Changes in canopy composition** can alter light availability and leaf litter and may not be favorable to the persistence of the orchid. For example, beech-dominated forests can shift to hemlock-dominated forests. Such changes appear to have occurred at several sites, and the orchid is less prevalent than at beech-dominated sites. Any

factors that result in beech decline are especially problematic. Both global warming (Iverson et al. 1999) and diseases affecting beech may result in the decline of beech in New England and the consequent decline of *T. trianthophora*. Diseases such as beech bark disease, caused by the combined attack of the woolly beech scale (*Cryptococcus fagisuga*) and a fungus (*Nectria coccinea*) (Pirone 1978) can result in beech decline. The distribution of beech may change significantly as a result of global warming with increased temperatures causing the extirpation of beech from southern New England and much of New York (Iverson et al. 1999).

- **Stochastic events** may adversely affect or eliminate the small populations present at many sites. Examples include inadvertent disturbances caused by road maintenance and changes in soil and leaf litter conditions or vegetation caused by unpredictable tree falls or storms.
- **Low genetic diversity** may threaten the long-term viability of populations and the species. Although no information exists on genetic diversity in the taxon, diversity may be low due to the small size of many populations and the potentially high reliance on vegetative rather than sexual reproduction. Genetic problems resulting from low genetic diversity such as inbreeding depression may not be a serious threat if the orchid reproduces primarily vegetatively. However, low genetic diversity may still compromise the evolutionary potential of plant species in the face of environmental change.
- **Inadvertent trampling** may occur during recreational use, timber harvest, monitoring, scientific research, and other activities.
- **Herbivory** appears to be common at many *Triphora* sites. It is unknown what impact herbivory has on the populations.
- **Collection** of the orchid would be detrimental to populations; it is unknown if collection is currently a serious problem for the taxon.

## DISTRIBUTION, ABUNDANCE, AND STATUS

### General Status

*Triphora trianthophora* occurs in Ontario, Canada, in New England (except Connecticut (H) and Rhode Island (SRF)), south to Florida and west to Nebraska (except Pennsylvania (H), Minnesota, North Dakota, and South Dakota) and south to Texas. It occurs in 30 states, but it is rare throughout much of its range in the United States. *Triphora trianthophora* is an S1 or S2 species in 19 states and in Ontario (Association for Biodiversity Information 2000, Association for Biodiversity Information 2001, and personal communications with Natural Heritage Program botanists and data managers). The taxon occurs as well in some localities in Central America including Mexico, Guatemala, and Panama (Correll 1950, Case 1964, Medley 1996). Globally, the orchid is ranked as a G3/G4 species (Association for Biodiversity Information 2000). In New England, *T. trianthophora* is an S1 or S2 species in Maine (T), New Hampshire (T), Vermont (T), and Massachusetts (E). The taxon is historic in Connecticut. *Triphora trianthophora* is a Division 2a species (potentially greater than 20 occurrences, but with a

substantial number of occurrences consisting of small numbers of individuals) according to *Flora Conservanda* (Brumback and Mehrhoff et al. 1996). Table 1 summarizes the distribution and status of *T. trianthophora* in the United States and Canada. The table reflects what is believed to be the most accurate information derived from multiple sources (Fernald 1950, Gleason and Cronquist 1991, Association for Biodiversity Information 2000, Association for Biodiversity Information 2001, and personal communications with Natural Heritage Program botanists and data managers). Figures 1 through 3 show the North American and New England distributions of current and historic occurrences.

<b>Table 1. Occurrence and status of <i>Triphora trianthophora</i> in the United States and Canada based on Information from Natural Heritage Programs.</b>			
<b>OCCURS &amp; LISTED (AS S1, S2, OR T &amp; E)</b>	<b>OCCURS &amp; NOT LISTED (AS S1, S2, OR T &amp; E)</b>	<b>OCCURRENCE REPORTED</b>	<b>HISTORIC (LIKELY EXTIRPATED)</b>
Delaware (S1; E)	Florida (S3)	Alabama (SR): relatively frequent throughout state	Connecticut (SC*; believed extirpated)
Kansas (S2; T)	Georgia (S3?): occurs in at least 4 counties)	Arkansas (SR)	Pennsylvania (SH)
Louisiana (S1; T)	Illinois (S3?)	Missouri (occurs in 20-25 counties)	District of Columbia (SH)
Maine (S1; T)	Indiana (S?)	Tennessee (occurs in about 15 counties)	Maryland (SH; X)
Massachusetts (S1; E)	Iowa (S3)	Texas (SR)	
Michigan (S1; T)	Kentucky (S?)		
Mississippi (S2S3)			
Nebraska (S1; E)			
New Hampshire (S2; T)			
New Jersey (S1; E)			
New York (S1S2; E)			
North Carolina (S2)			
Ohio (S2; T)			
Oklahoma (S2S3)			
Ontario, Canada (S1; E)			
South Carolina (S2; SC)			
Vermont (S1; T)			
Virginia (S1; E)			
West Virginia (S2)			
Wisconsin (S2; SC)			



**Figure 1. Occurrences of *Triphora trianthophora* in North America.** States and provinces shaded in gray have confirmed, extant occurrences of the taxon. Diagonal hatching indicates states where the taxon is historic or presumed to be extirpated (see Appendix for explanation of ranks).



**Figure 2. Extant occurrences of *Triphora trianthophora* in New England.** Town boundaries for New England are shown. Towns with shading have 1-5 current occurrences of the taxon.



**Figure 3. Historic occurrences of *Triphora trianthophora* in New England.** Town boundaries for New England are shown. Towns with shading have 1-5 historic records for the taxon.

### Status of all New England Occurrences-- Current and Historic

*Triphora trianthophora* occurs in southwestern Maine, central-eastern New Hampshire, southeastern Vermont, and northwestern Massachusetts. The taxon is historic in Connecticut. Twenty-four current occurrences (seen after 1970) are found in New England. The majority of the current occurrences (17 of 24) are in Maine and New Hampshire. Nineteen current occurrences have been documented recently. Three current occurrences are still listed by Natural Heritage Programs as extant, but are possibly extirpated. There are two additional New Hampshire occurrences that have been seen but were not documented in the Heritage Program data base as of 2000 (Sara Cairns, New Hampshire Natural Heritage Program, personal communication) and perhaps a third population not listed in the data base (Frankie Brackley Tolman, consulting botanist, personal communication). There are 19 documented historic occurrences of the taxon.

Occurrences of *Triphora trianthophora* in Maine, New Hampshire, Vermont, and Massachusetts exhibit similarities in terms of habitat and threats to the occurrences. *Triphora trianthophora* occurs in mesic northern hardwood forests with beech typically a dominant species. At the Vermont site, hemlock dominates, although a few beech are present. Plants occur most frequently in substantial leaf litter in shallow depressions. Sites are often rocky. The moisture regime is usually mesic but may be dry-mesic, and light conditions are usually filtered and less commonly shaded. Most of the New England sites range in elevation from 200 to 900 feet (61-274 meters); three sites range from 1250-1420 feet (381-433 meters). Slope of the sites ranges from 0-35%; about two-thirds of the sites are S, SE, or E-facing. There are typically few herbaceous or shrub species in the immediate vicinity of *T. trianthophora* plants, but *Epifagus virginiana*, *Monotropa uniflora*, *Uvularia sessilifolia*, *Gaultheria procumbens*, *Mitchella repens*, and *Medeola virginiana* often occur nearby. The following threats have the potential to occur at the majority of sites: timber harvest; development; habitat alteration; competition from understory plants; changes in canopy composition; stochastic events affecting small populations; herbivory; recreation; ice storms; proximity to roads; inadvertent trampling; collection; and canopy closure.

Table 2 presents information on each of the New England occurrences of *Triphora trianthophora*. Data from state Natural Heritage programs is the primary source for the information as well as site visits by the author in 2000. The table includes information on location, type of ownership, first and last observation dates, site description, element occurrence rank, population size and trend, general comments, and threats. The element occurrence ranking should be considered subjective as the ranking is assigned by different investigators who may or may not have visited more than one occurrence. Several occurrences have no ranking information available. The section following the table provides a more detailed discussion of each occurrence in narrative form.

**Table 2.** New England Occurrence Records for *Triphora trianthophora*. Shaded occurrences are considered extant.

State	EO #	County	Town	Site Ownership	First Obs.	Last Obs.	Description	EO Rank	Population Size (date); trend	Comments	Threats
ME	.001	Oxford	Stow	White Mountain National Forest	1969	2000	Beech forest on SE facing rocky hillside, 0-35% upper slope; plants in beech and oak leaf litter in hollows; sandy-loam; dry-mesic conditions; filtered light	B	97 stems (2000); fluctuations, possible decline		Browsing; flower/fruit abortion; plants feeble; too much shade?; unknown impacts of potential timber harvest; possible hiking impacts
ME	.002	Oxford	Stow	White Mountain National Forest	1971	1989	Mature beech forest	B	100s (1989); no plants found (1991); possible decline		Unknown
ME	.003	Oxford	Stoneham	White Mountain National Forest & Private	1988	2000	Rich northern hardwood forest; filtered light; mesic conditions; SSE-facing, 10-35% mid lower slope; mica schist and boulders; sandy loam	B	64 stems (2000); likely decline		Unknown impacts of heavy ice storm damage; unknown impacts of potential timber harvest; small population size
ME	.004	Oxford	Hiram	Private	1975	1996	Beech dominated mesic forest; few understory plants on rocky SE-facing, 10-35% hill on glacial till; plants are in beech-leaf lined hollows; filtered light	AB	24 individuals (only 2 reproductive) (1996); fluctuations, likely decline	A very small population EO Rank may be too high.	Unknown impacts of potential timber harvest; minor natural erosion on steep slope and gully; small population size

**Table 2.** New England Occurrence Records for *Triphora trianthophora*. Shaded occurrences are considered extant.

State	EO #	County	Town	Site Ownership	First Obs.	Last Obs.	Description	EO Rank	Population Size (date); trend	Comments	Threats
ME	.005	Cumberland	Raymond	Private	1977	2000	Rocky beech forest; filtered light; mesic conditions; WNW, 0-10% lower slope; fine to medium sand	BC	~230 stems (2000); fluctuations	A relatively large population confronted with threats of development and inadvertent disturbance	Potential of development at site; numerous plants along powerline that is used as a walking path; firewood collection for campfires
ME	.006	Oxford	Stow	Private	1975	1975	Mixed hardwood forest (mostly beech) on dry, rocky hillside	C	15 stems (1975); likely decline, possibly extirpated	Technically a current occurrence, but plants not found '94 & '95. Population possibly extirpated	Dense understory may create competition; small population size
ME	.007	York	Parsonfield	Private	1995	2000	Open beech woods with heavy leaf litter; also, young woods after a heavy 1980's cut; very stony, fine sandy loam; filtered light; moist to dry-mesic conditions; SSE 0-35% midslope	A	346 stems (2000); fluctuations	A relatively large population that is currently protected by private landowners	Insect damage; unknown impacts of succession in young woods

**Table 2.** New England Occurrence Records for *Triphora trianthophora*. Shaded occurrences are considered extant.

State	EO #	County	Town	Site Ownership	First Obs.	Last Obs.	Description	EO Rank	Population Size (date); trend	Comments	Threats
NH	.001	Carroll	Madison	Unknown	1983	1999	CNE mesic transitional forest (beech forest); acidic bedrock/till (granitic) partial light; dry-mesic-mesic conditions; <5% slope SE-facing	C	7 stems (1999); decline	A very small population	Unknown impacts from severe ice storm damage; plants feeble; unknown impacts from cutting; small population size
NH	.002	Carroll	Conway	Unknown	1983	1983	Mesic northern hardwoods; granitic/sandy loam; mesic conditions; light: shade; W-facing 10-35% lower slope	CD	10-15 plants (1983); unknown	A very small population	Near road; logging; development; small population size
NH	.003	Carroll	Madison	Private	1984	2000	CNE mesic transitional forest (beech woods with deep litter where plants are found); acidic bedrock/till; filtered-shaded light; mesic conditions; S-facing 10-35% slope	B	~ 100 stems (2000); possible decline		Unknown impacts of past and potential timber harvest; development; potential competition from relatively dense understory
NH	.004	Carroll	Wakefield	Private	1985	2000	Oak-beech forest; CNE mesic transitional forest with almost no herbs in understory: acidic bedrock/till; sandy	B	~ 100 stems (2000); fluctuations		Unknown impacts of potential timber harvest; some plants near roadside; high activity area with possible trampling

**Table 2.** New England Occurrence Records for *Triphora trianthophora*. Shaded occurrences are considered extant.

State	EO #	County	Town	Site Ownership	First Obs.	Last Obs.	Description	EO Rank	Population Size (date); trend	Comments	Threats
							loam with cobbles and boulders; filtered-shaded light; mesic conditions; ESE-facing, 15 degree slope				
NH	.005	Carroll	Albany	Private	1986	2000	Mixed northern hardwood forest with beech; sparse ground cover; dry-mesic midslope; filtered light; mid-slope on a S-facing, 8-15% slope; large granitic boulders; sandy-loam	A	~ 259 stems (2000); fluctuations	An outstanding population in excellent natural habitat; protection possibilities unknown	Several plants with broken/eaten off flowers; unknown impacts of potential timber harvest; potential development
NH	.006	Grafton	Holderness	Private	1983	2000	Beech woods; plants in hollows and other areas with thick leaf litter; sparse understory; filtered-shaded light; dry-mesic-mesic conditions; nearly flat E-facing slope	A	~ 130 stems, likely many more (2000); fluctuations, possible decline	A large population; private landowners are aware of plant and concerned about it	Impacts of roadside brush cutting on roadside plants and other roadside impacts; unknown impacts of potential timber harvest; herbivory; possible development
NH	.007	Carroll	Tamworth	Unknown	1904	1915	Unknown	H	Possibly extirpated		Unknown
NH	.008	Belknap	Laconia	Unknown	1901	1901	Unknown	H	Possibly extirpated		Unknown

**Table 2.** New England Occurrence Records for *Triphora trianthophora*. Shaded occurrences are considered extant.

State	EO #	County	Town	Site Ownership	First Obs.	Last Obs.	Description	EO Rank	Population Size (date); trend	Comments	Threats
NH	.009	Belknap	Meredith	Unknown	1903	1903	Unknown	H	Possibly extirpated		Unknown
NH	.010	Carroll	Tamworth	Unknown	1904	1940	Unknown	H	Possibly extirpated		Unknown
NH	.011	Carroll	Chatham	White Mountain National Forest	1976	1978	Small hollows with litter; beech and oak	?	70 (1978); decline likely; plants not found 1996		Unknown; small population size
NH	.012	Grafton	Holderness	Unknown	1876	1876	Unknown	H	Possibly extirpated		Unknown
NH	.013	Cheshire	Winchester	Unknown	1916	1916	Unknown	H	Possibly extirpated		Unknown
NH	.014	Hillsborough	Milford	Unknown	1899	1899	Unknown	H	Possibly extirpated		Unknown
NH	.015	Carroll	Chatham	White Mountain National Forest	1992	1992	Glacial cirque with coarse-grained quartzite and/or mica schist	?	Unknown; Unknown		Unknown
NH	.016	Carroll	Conway	Unknown	1890	1905	Unknown	H	Possibly extirpated		Unknown
NH	.017	Hillsborough	Hillsborough	Unknown	1909	1909	Unknown	H	Possibly extirpated		Unknown
NH	.018	Carroll	Bartlett	Unknown	1879	1879	Unknown	H	Possibly extirpated		Unknown
NH	.019	Grafton	Holderness	Unknown	1917	1917	Beech woods	H	Possibly extirpated		Unknown
NH	.020	Carroll	Sandwich	Private	1996	1996	Shallow, rocky depression with	?	Limited to 20' square area	Owners interested	Possible impacts from foot traffic;

**Table 2.** New England Occurrence Records for *Triphora trianthophora*. Shaded occurrences are considered extant.

State	EO #	County	Town	Site Ownership	First Obs.	Last Obs.	Description	EO Rank	Population Size (date); trend	Comments	Threats
							heavy leaf litter		(1996); unknown	in conservation of orchid and habitat	possible impacts from canopy closure
NH	.021	Carroll	Albany	White Mountain National Forest	1995	2000	Beech dominated forest; plants in shallow depressions; sandy, gravelly loam; granite boulders; SSE-facing 0-20 degree slope	AB	425 stems (2000); unknown, possible increase, but likely due to differences in plant apparency	A large and extensive population ; heavy logging has impacted a portion of the occurrence	Impacts from heavy logging
VT	.001	Windham	Dummers ton	Private	1981	1981	Beech and hemlock forest; hemlock and oak predominate now (2000); granitic bedrock; mesic conditions; filtered-shaded light in forest; open light in logged areas	?	11 plants (1981); decline or extirpation likely	Technicall y a current occurrence , but plants not found '91, '95, '98, & '00; population possibly extirpated	Unknown impacts of potential timber harvest; potential development; small population size
VT	.002	Windham	Brattleboro	Brattleboro Dept. of Public Works and Private	1981	2000	Hemlock dominated woods with few beech; plants above a small stream and culvert and roadside; light: filtered-shade	C	35 stems (2000); likely stable currently	Roadside occurrence is vulnerable to substantial threats	Close proximity to roadside and ditch; an upstream culvert that needs repair; small population size

**Table 2.** New England Occurrence Records for *Triphora trianthophora*. Shaded occurrences are considered extant.

State	EO #	County	Town	Site Ownership	First Obs.	Last Obs.	Description	EO Rank	Population Size (date); trend	Comments	Threats
							filtered-shade				
VT	.003	Windham	Brookline	Private	1981	2001	Currently disturbed area--cleared, leveled, and new house (1998); Hemlock, beech, maple woods. Plants in leaf-lined hollows, often near boulders	BC	13 plants (1981); Plants not found '95, '98; 13 stems found (2001)	A small population in woods flanked by two houses	Small size of population and habitat vulnerable; unknown future land use; potential successional changes in canopy and habitat
VT	.004	Rutland	Fair Haven	Unknown	1842	1842	Unknown	H	Possibly extirpated		Unknown
VT	.005	Windham	Newfane	Unknown	1897	1898	Hollows of cradle knolls in beech woods	H	Few (1898); possibly extirpated		Unknown
VT	.007	Windham	Westminster	Unknown	1899	1899	On a rotten stump	H	1 plant (1899); possibly extirpated		Unknown
VT	New	Windham	Dummers ton	Private Conserv-ation organization	2001	2001	Deciduous woods dominated by beech; filtered light; dry-mesic conditions; SSW-facing; 10-20% slope; granitic boulders common	AB	Approximately 100 stems	Possibly Vermont's best population	No substantial threats known; possible understory competition, inadvertent trampling, and disturbance
MA	.001	Franklin	Greenfield	Private	1981	1981	Beech and hemlock woods; leaf-lined depression; E-facing mid-slope	?	2 plants (1981); possibly extirpated	Technically a current occurrence, but population	Development; Unknown impacts of potential timber harvest; small population size

**Table 2.** New England Occurrence Records for *Triphora trianthophora*. Shaded occurrences are considered extant.

State	EO #	County	Town	Site Ownership	First Obs.	Last Obs.	Description	EO Rank	Population Size (date); trend	Comments	Threats
							(0-20 degrees); light: shade; mesic conditions; acid soil assumed			possibly extirpated	population size
MA	.003	Franklin	Deerfield	Unknown	1913	1913	Unknown	H	Possibly extirpated		Unknown
MA	.004	Franklin	Rowe	New England Power Company (Private)	1986	2000	Relatively rich mesic forest; plants in hollows; light: shade; steep slope (20-75 degrees), S-facing, mid-slope	A	700-800 plants estimated (2000); fluctuations, likely relatively stable	A large, extensive population in good quality habitat; protection possibilities currently good	Herbivory apparent
MA	.005	Franklin	Conway	Unknown	1928	1928	Unknown	H	Possibly extirpated		Unknown
MA	.006	Berkshire	Florida	Private	2000	2000	Beech-dominated midslope; plants in hollows with leaf litter deposits and along logging paths; light: shade; mesic; 0-20% slope	B	35 stems (2000); unknown trend	Much potential habitat remains to be searched. Protection possibilities good	Unknown long-term impacts from recent microburst and selective logging
CT	.001	New Haven	New Haven	Unknown	1879	1879	Rich hemlock woods	H	Possibly extirpated		Unknown
CT	.002	Hartford	Southington	Unknown	1906	1920	Rocky woods near Lake Compounce	H	Possibly extirpated		Unknown

**Table 2.** New England Occurrence Records for *Triphora trianthophora*. Shaded occurrences are considered extant.

State	EO #	County	Town	Site Ownership	First Obs.	Last Obs.	Description	EO Rank	Population Size (date); trend	Comments	Threats
CT	.003	New London	Norwich	Unknown	No data	No data	Unknown	H	Possibly extirpated		Unknown

The following descriptions are based on information obtained from state Natural Heritage programs, field visits by the author in 2000, and discussions with several persons knowledgeable about the occurrences. All available information from these sources is included for each occurrence.

### Status of Maine occurrences

Maine has seven current occurrences. Five of these populations were last seen between 1996 and 2000, and two populations were not seen when last visited in the 1990s. Reported population size ranges from only five stems to nearly 350 stems; only two occurrences had greater than 100 stems at the most recent surveys. Four of the occurrences exhibited possible declines, and most of the occurrences exhibited apparent fluctuations. However, population size is extremely difficult to assess. Two of the sites are publicly owned (White Mountain National Forest), one has public (White Mountain National Forest) and private ownership, and four sites are privately owned. There are no reported historic occurrences for Maine. There is an additional occurrence in the township of Brownfield (Frankie Brackley Tolman, consulting botanist, personal communication).

**ME .001 (Stow)** -- This occurrence is located in the White Mountain National Forest in a forest dominated by *Fagus grandifolia* on a southeast-facing rocky hillside (0-35% mid-slope). Moisture conditions are mesic to dry-mesic, and light conditions are filtered. Elevation ranges from 1050 to 1200 feet (320-366 meters). Soils are a sandy loam. In addition to *Fagus grandifolia*, other canopy species present include *Quercus rubra*, *Acer saccharum*, *Betula alleghaniensis*, *Ostrya virginiana* and *A. rubrum*. Prominent species in the understory include *A. pensylvanicum*, *O. virginiana*, and *A. rubrum*. *Triphora trianthophora* grows primarily in hollows filled with beech and oak leaf litter; the species tends to occur with few other species, but associated species growing nearby include *Epifagus virginiana*, *Uvularia sessilifolia*, *Maianthemum canadense*, *Mitchella repens*, *Gaultheria procumbens*, and *Monotropa uniflora*. In 2000, 97 stems were located; the population has fluctuated from 35 plants to hundreds of plants recorded. The occurrence was first recorded in 1969 and monitored again in 1970, 1976, 1989, 1991, 1997, and 2000. The most immediate threat to the occurrence is the proximity of numerous plants to a trail. Additional threats include impacts of herbivory, possible impacts of canopy closure, unknown impacts of light ice storm damage, and impacts of any future timber harvest.

**ME .002 (Stow)** -- This occurrence is located in the White Mountain National Forest. The site is a mature forest dominated by *Fagus grandifolia* with *Betula papyrifera*, *B. alleghaniensis*, *Quercus rubra*, and *Acer saccharum* occurring as well. The site was first reported in 1971 and visited again in 1976, 1984, 1989, and 1991. The occurrence is potentially a vigorous one; hundreds to a thousand plants were reported. However, no plants were found in 1991; hundreds of plants were reported in 1989.

**ME .003 (Stoneham)** -- This White Mountain National Forest site occurs in an enriched northern hardwood forest. The site is a south to southeast-facing mid to lower-slope (10-35%). Light conditions are filtered, and moisture conditions are mesic. Soils are a sandy loam with mica schist and numerous boulders present. Elevation ranges from 640 to 1300 feet (195-396 meters). Dominant tree species include *Fagus grandifolia*, *Quercus rubra*, *Acer rubrum*, *Populus grandidentata*, and *Betula papyrifera*. *Triphora trianthophora* grows primarily in hollows filled with beech leaf litter; the species tends to occur with few other species, but associated species growing nearby include *Epifagus virginiana*, *Medeola virginiana*, *Monotropa uniflora*, *Gaultheria procumbens*, *Uvularia sessilifolia*, and *Clintonia borealis*. In 2000, 64 stems were located. The occurrence was first recorded in 1988 and visited again in 1989, 1991, 1997, and 2000. In the first two years of observation, thousands of plants were found. In 1991, no plants were found, and in 1997, 30 plants were found along a trail; a larger area was not searched. In 1989, the occurrence was described as an outstanding example with hundreds

of plants in excellent quality habitat. In 2000, the population was much smaller, and the habitat was at least temporarily greatly diminished with respect to suitability for *T. trianthophora*. A recent ice storm caused substantial damage to the canopy and has led to very dense undergrowth in numerous locations and no evidence of *Triphora* stems. Additional threats to the occurrence include proximity of many plants to the trail and the potential for timber harvest.

**ME .004 (Hiram)** -- This occurrence is in a young beech-dominated forest on a rocky southeast-facing hillside (10-35% slope). The site is privately owned. Filtered light conditions and mesic moisture conditions exist. Soil is glacial till. The canopy is dominated by *Fagus grandifolia* with scattered *Pinus strobus*, *Quercus rubra*, *Acer saccharum* and *Betula papyrifera*. *Triphora trianthophora* grows primarily in hollows filled with beech leaf litter; the species tends to occur with few other species, but associated species growing nearby include *Epifagus virginiana*, *Monotropa uniflora*, and *Corallorhiza odontorhiza*. In 1996, 24 individuals were found and only two of these were reproductive. The occurrence was first documented in 1975 and monitored again in 1979, 1983, 1984, 1985, 1995, and 1996. On most occasions, tens of plants were found, on two occasions no plants were found, and on one occasion over a hundred plants were found. Threats include the potential for timber or firewood harvest, minor natural erosion on a steep slope and gully, and small population size.

**ME .005 (Raymond)** -- This occurrence is in a rocky beech forest on a west northwest-facing lower slope (0-10% slope). Light conditions are filtered and the moisture conditions are mesic. The soil is fine to medium sand, and there are numerous boulders present. Elevation is approximately 275 feet (84 meters). The canopy is dominated by *Fagus grandifolia* and *Tsuga canadensis*. *Hamamelis virginiana*, *Acer rubrum*, and *Quercus rubra* also occur. *Triphora trianthophora* grows primarily in hollows filled with beech leaf litter; the species tends to occur with few other species, but associated herbaceous species growing nearby include *Gaultheria procumbens*, *Medeola virginiana*, *Mitchella repens*, *Epifagus virginiana*, and *Corallorhiza maculata*. In 2000, approximately 230 stems were located. The population appears to have fluctuated since it was first documented in 1977 with greater than 200 individuals; in 1984 six to 10 individuals were located, and in 1995, 86 individuals were found. Threats to the occurrence include its proximity to a commercial recreational area (trampling that may result from use of a walking path and firewood collection, powerline maintenance, and potential development). The general area is fairly heavily used. Ownership is by a private company and private individual(s).

**ME .006 (Stow)** -- This occurrence was initially reported from a mixed hardwood forest dominated by beech on a dry rocky hillside. Elevation is approximately 600 feet (183 meters). The occurrence was first located in 1975 when 15 stems were found; subsequent attempts to locate the plant in 1994 and 1995 were unsuccessful. According to the most recent surveyor, a portion of the area in which the plants occurred is now cut and manicured. Associated species regenerating in the area include *Viburnum alnifolium*, *Betula papyrifera*, *Fagus grandifolia*, and *Acer pensylvanicum* and ground cover is much thicker than is typical for other sites. The population of *Triphora trianthophora* may now be extirpated at this site.

**ME .007 (Parsonfield)** -- This occurrence is located in an open beech woods with substantial leaf litter and in a young woods growing back after a very heavy cut. Plants occur midslope on a south southeast facing slope (0-35%). Soil is a very stony fine sandy loam. Elevation is approximately 600-700 feet (183-213 meters). The canopy is dominated by *Fagus grandifolia*, *Betula papyrifera*, and *Tsuga canadensis*. Few associated herbaceous or shrubby species occur in the more mature beech forest; *Rubus alleghaniensis*, *Rubus idaeus*, *Dennstaedtia punctilobula*, *F. grandifolia*, *Betula papyrifera* saplings and *Hamamelis virginiana* and *Acer pensylvanicum* occur in the area growing back after the cut. About half of the plants occur in the open beech

woods in heavy beech leaf litter in small hollows; the other half occur in the recently cut area. When first reported in 1995, there were over 200 plants. In 1996, 415 individuals were reported, 225 in 1997, 500 in 1999, and 346 in 2000. Knowledgeable and conservation-minded individuals own the site; they first located the plant and monitor it regularly. Threats include unknown impacts of succession in young woods and damage from unknown insects.

### **Status of New Hampshire occurrences**

New Hampshire has 10 current occurrences. Eight of these populations were last seen between 1992 and 2000. Two populations were last seen in the late 1970s and early 1980s. There are also several occurrences known in New Hampshire that have not been officially reported to the Natural Heritage Program. There are 11 historic occurrences. Population sizes for current occurrences are two with 15 or fewer stems; one with 70 stems; four with 100-259 stems; one with over 400 stems; and two with no information. For current populations, four exhibit possible declines, one a possible increase, three exhibit apparent fluctuations, and trends for the others are unknown. Five of the sites are privately owned, three are publicly owned (White Mountain National Forest), and ownership of two sites is unknown. Ownership of the historic sites is unknown. There may be an additional occurrence in Holderness or an incorrect first observation date on the Holderness occurrence listed (Frankie Brackley Tolman, consulting botanist, personal communication) and two additional occurrences in Chatham (Sara Cairns [New Hampshire Natural Heritage Program] and Sarah Schwaegler [Consulting Botanist], personal communication).

**NH .001 (Madison)** -- This occurrence is in a beech-dominated northern dry-mesic to mesic hardwood forest. The site is on a gentle (12 degrees) southeast-facing slope with granitic bedrock and sandy loam soil with boulders. Partial light conditions exist. Elevation is 780 feet (238 meters). In addition to *Fagus grandifolia*, associated species include *Acer pensylvanicum*, *Aralia nudicaulis*, *Uvularia sessilifolia*, and *Epifagus virginiana*. The occurrence was first discovered in 1983 when between 51-100 plants were found, and was described as an excellent population. The population was monitored again in 1999 when only seven stems were found; the site was severely impacted by an ice storm and some cutting. Threats include unknown impacts of succession after an ice storm, potential of additional cutting (easily accessible in 1983 by well-maintained logging road), and stochastic events that could eliminate the small population. Ownership is unknown.

**NH .002 (Conway)** -- This occurrence is in a mesic northern hardwood forest. Plants grow on a west facing 10-35% lower slope. Bedrock is granitic, and soil is a sandy loam. Light conditions are shady. Elevation is 740-780 feet (225-238 meters). The forest consists of *Fagus grandifolia*, *Tsuga canadensis*, and *Quercus rubra*. The population was first documented in 1983; however, there are apparently older records for the site. It has not been documented since. 10-15 plants were discovered in 1983. Threats in 1983 included proximity to road, logging, development, and stochastic events that could eliminate the small population.

**NH .003 (Madison)** -- This occurrence is in a central New England mesic transitional forest. Plants grow on a south facing 10-35% slope on acidic bedrock and till; the plants are typically found in deep beech and oak leaf litter in small depressions. Light conditions are filtered to shaded. Elevation is about 800 feet (244 meters). Dominant tree species include *Quercus rubra*, *Fagus grandifolia*, *Pinus strobus*, and *Pinus resinosa*. Associated species include *Hamamelis virginiana*, *Viburnum* sp., *Acer pensylvanicum*, *Dennstaedtia punctilobula*, *Uvularia sessilifolia*, and beech and ash seedlings. In general, the site has more herbaceous and shrub cover than is typical of *Triphora trianthophora* sites. The orchid typically occurs at this site in hollows and where little else is growing. The occurrence was first documented in 1984 when 218 plants were found in a rough count; more

plants likely occurred at the site. The site was resurveyed in 2000, and about 100 stems were found. Threats to the occurrence include: unknown impacts of past and potential timber harvest; proximity of some plants to road; trampling; competition from relatively dense understory; and stochastic events that could eliminate the relatively small population. Ownership is private, and the landowner is aware of the orchid and concerned about it.

**NH .004 (Wakefield)** -- This occurrence is in a central New England mesic transitional forest (oak-beech forest) on an east southeast-facing 15 degree slope. Bedrock is acidic, and soil is a sandy loam with cobbles and boulders. Light conditions are filtered to shaded. Elevation is approximately 750 feet (229 meters). Dominant tree species include *Fagus grandifolia*, *Betula lenta*, *B. papyrifera*, *Quercus rubra*, *Acer rubrum*, and *A. saccharum*; shrubs and herbaceous associated species at the site include *A. pensylvanicum*, *Hamamelis virginiana*, *Viburnum alnifolium*, *V. acerifolium*, *Epifagus virginiana*, *Monotropa uniflora*, and *Uvularia sessilifolia*. *Triphora trianthophora* grows primarily in hollows filled with beech leaf litter; the orchid is found at this site with no immediate associated species except a few beech seedlings. The occurrence was first documented in 1985 when 101-1000 plants were noted. The population was monitored again in 1987 (same status), 1992 (32 plants; monitored in October), 1993 (25 plants in a cursory search), 1999 (123 stems), and 2000 (approximately 100 stems). Ownership is private, and owners are aware of the orchid. Threats include: potential trampling (substantial trash in vicinity); unknown impacts of potential timber harvest (current logging in vicinity, but not in specific area where plants occur); and proximity of some plants to roadside.

**NH .005 (Albany)** -- This occurrence is in a mixed northern hardwood forest dominated by beech. Plants occur on a south facing dry-mesic midslope (8-15%). Soil is a sandy loam with large granitic boulders. Light is filtered. Elevation ranges from 740-800 feet (225-244 meters). Canopy species include *Fagus grandifolia*, *Quercus rubra*, *Populus grandidentata*, *Betula papyrifera*, and *Acer rubrum*. Ground cover is sparse at the site. *Triphora trianthophora* grows primarily in hollows filled with thick beech leaf litter. The species tends to occur with few other species, but associated herbaceous species growing nearby include *Gaultheria procumbens*, *Uvularia sessilifolia*, *Epifagus virginiana*, *Medeola virginiana*, *Maianthemum canadense*, *Monotropa uniflora*, *Vaccinium* spp., and *Aralia nudicaulis*. The occurrence was first documented in 1986 when hundreds of plants were found. In 1991, no plants were found, and in 1998, fewer than 50 plants were observed. In 2000, there were about 259 stems observed. This is an excellent site in terms of current undisturbed nature of habitat and population size and vigor. Threats include unknown impacts of any future timber harvest and potential development. The site is privately owned.

**NH .006 (Holderness)** -- This occurrence is in a dry-mesic to mesic beech forest. The site is gently north, northeast facing (0-3% slope). The light regime is filtered to shaded. Elevation ranges from 640-680 feet (640-680 meters). *Fagus grandifolia* dominates the canopy; other tree species include *Betula papyrifera*, *Picea rubens*, and *Acer pensylvanicum*. *Triphora trianthophora* grows primarily in hollows filled with thick beech leaf litter; the species tends to occur with few other species, but associated herbaceous species growing nearby include *Epifagus virginiana*, *Aralia nudicaulis*, *Gaultheria procumbens*, *Monotropa uniflora*, *Aster* sp., and others. The occurrence was first documented in 1987 when over 5000 plants were found. In 1989, there were fewer plants, and in 1990, over 1000 plants were found. In 2000, 130 stems were located in a cursory search; there were likely many more. Threats include impacts of roadside brush cutting and other maintenance activities associated with the road, unknown impacts of potential timber harvest, unknown impacts of herbivory, and potential future development. The site is privately owned and the owners are aware of the plant and concerned about it.

**NH .007 (Tamworth)** -- This occurrence was initially documented in 1904 and last seen in 1915. The occurrence is considered historic.

**NH .008 (Laconia)** -- This occurrence was seen and documented only in 1901. The occurrence is considered historic.

**NH .009 (Meredith)** -- This occurrence was seen and documented only in 1903. The occurrence is considered historic.

**NH .010 (Tamworth)** -- This occurrence was initially documented in 1904 and last seen in 1940. The occurrence is considered historic.

**NH .011 (Chatham)** -- This occurrence is in a beech and oak forest on a southwest facing slope with plants growing in small hollows with beech leaf litter. Elevation is 1420 feet (433 meters). The occurrence was first documented in 1976, when several small colonies were located. In 1978, 70 plants were found, and in 1996, no plants were found. Aside from the relatively small population size, specific threats have not been identified. Ownership is public (White Mountain National Forest).

**NH .012 (Holderness)** -- This occurrence was seen and documented only in 1876. The occurrence is considered historic.

**NH .013 (Winchester)** -- This occurrence was seen and documented only in 1916. The occurrence is considered historic.

**NH .014 (Milford)** -- This occurrence was seen and documented only in 1899. The occurrence is considered historic.

**NH .015 (Chatham)** -- This occurrence was first documented in 1992 and apparently has not been revisited since that date. Information focuses on plant communities located in a relatively large area and does not provide detail on *Triphora trianthophora*. The site is in a mesic transitional forest at an elevation of about 700 feet (213 meters). Ownership is public (White Mountain National Forest).

**NH .016 (Conway)** -- This occurrence was initially documented in 1890 and last seen in 1905. The occurrence is considered historic.

**NH .017 (Hillsborough)** -- This occurrence was seen and documented only in 1909. The occurrence is considered historic.

**NH .018 (Bartlett)** -- This occurrence was seen and documented only in 1879. The occurrence is considered historic.

**NH .019 (Holderness)** -- This occurrence was seen and documented from a beech woods only in 1917. The occurrence is considered historic.

**NH .020 (Sandwich)** -- This occurrence is located in second-growth white pine-hemlock forest on a peninsula of a large lake. The site is on moist, shallow-to-bedrock soils on rocky, gently sloping ground. Elevation is 580

feet (177 meters). *Fagus grandifolia* and *Tsuga canadensis* are the dominant tree species with *Pinus strobus*, *Betula papyrifera*, and *Acer saccharum* occurring as well. The *Triphora trianthophora* population grows in a shallow, rocky depression with thick leaf litter about 200 feet upslope from shore. The population may be limited to a 20 square foot area (1.86 square meters). Associated herbaceous species include *Epifagus virginiana*, *Pyrola* sp., and *Gaultheria procumbens*. The occurrence was initially documented in 1996 and apparently has not been revisited. Threats to the occurrence include small apparent extent of the population and small population size, potential for inadvertent trampling from recreational use, and unknown impacts of canopy closure. Ownership is private, and the owners are aware of the plant and in 1996 expressed interest in making the site part of a land trust-owned natural area.

**NH .021 (Albany)** -- This occurrence is in a beech-dominated forest on a south to southeast-facing slope (0-20 degrees). The soil is a sandy, gravelly loam with granitic boulders present. The site ranges from about 860 to 920 feet (262-280 meters) in elevation. *Fagus grandifolia* dominates, and *Betula papyrifera*, *B. alleghaniensis*, and *Quercus rubra* occur as well. *Triphora trianthophora* grows primarily in hollows filled with thick beech leaf litter; the species tends to occur with few other species, and the only associated herbaceous species growing nearby are *Epifagus virginiana* and *Monotropa uniflora*, and beech seedlings are common. The occurrence was first documented in 1995, when about 60-70 stems were located in an approximately 10 acre area (4.05 hectares); dozens more were likely present. The orchid was seen again in 1998. In 2000, 425 stems were found in approximately two acres (.81 hectares); over half of these were in an area that was logged recently. The remaining plants were located in a 200 foot diameter area (61 meters) that was set aside as a control area and was not logged. Threats to the orchid include impacts resulting from the logging (changes in soil moisture, temperature, and light regimes, mycorrhizal associations, and increased density of understory resulting in competition for the orchid). The site is publicly owned (White Mountain National Forest), and monitoring of the logged and control sites is occurring. Some plants occur on adjacent, privately owned land as well.

### Status of Vermont occurrences

Vermont has four current occurrences, three of which have been seen since 1981. One population had 35 stems in 2000 and has fluctuated from year to year; the site is publicly (Town of Brattleboro) and privately owned. Two small populations (fewer than 15 plants) were documented in 1981. At one of these sites (Vermont .001 [Dummerston], no plants were found in 1991, 1995, 1998, and 2000. At the other site (Vermont .003 [Brookline], no plants were seen in 1995 and 1998, and the site was developed. However, the population was rediscovered in 2001. In addition, a new population was discovered in Dummerston in 2001. There are three historic occurrences reported; ownership information is unknown for these sites. An additional historic occurrence (quite abundant in a small woodlot) reported in 1899 from Putney (Blanchard 1902) is not in the Vermont Natural Heritage Program data base.

**VT .001 (Dummerston)** -- This occurrence is in a mesic beech and hemlock forest. Bedrock is granitic. The site is fairly level, and light conditions are filtered to shaded in areas not recently logged; open light conditions exist in logged areas. Elevation is approximately 1000 feet (305 meters). *Tsuga canadensis* and *Quercus rubra* now dominate. The occurrence was first documented in 1981, when 11 plants were located. The site and surrounding area was searched again in 1991, 1995, 1998, and 2000; no plants were found on any of these occasions. Directions to the original site are general, but the most likely area now has been logged and a tennis court is nearby. There is little suitable habitat (i.e., beech-dominated forest, areas with deep accumulations of beech leaf litter, mesic moisture conditions, filtered light conditions, and few or no co-occurring herbaceous and shrub species) for *Triphora trianthophora* currently. The Nature Conservancy and a local land trust or

conservation group now own the site. Adjacent land (privately owned by conservation-minded individuals who are interested in the orchid) was searched on at least two recent occasions and has some potential habitat, but no plants were found at times when plants were found at a nearby site. The original population was small when first discovered and may be extirpated now.

**VT .002 (Brattleboro)** -- This occurrence is near a roadside ditch below a hemlock-dominated hillside forest. Moisture conditions are mesic, and light conditions are filtered to shaded. Elevation is approximately 800 feet (244 meters). *Tsuga canadensis* dominates at the site, and there are a few scattered individuals of *Fagus grandifolia* and *Acer saccharum*. *Triphora trianthophora* grows primarily in hollows filled with thick beech leaf litter; the species tends to occur with few other species, and the only associated herbaceous species growing nearby is *Epipactis helleborine*. *Circaea* sp., *Impatiens* sp., and *Lactuca muralis* also occur nearby in the culvert. *Triphora trianthophora* is most dense in areas with the thickest leaf litter; areas that are somewhat eroded and have little litter contain no stems. The occurrence was first documented in 1981 when 17 plants were found; in 1982, 23 plants were found. In 1995, no plants were found. In 1998, 28 stems were found, but in 1999, no stems were found in the same location. In 2000, the site was checked on three dates during the flowering season, and the maximum number of stems located on one date was 34. In addition, one stem was found on the hillside a short distance from the original population in a shallow hollow with beech and oak leaf litter near an oak, two beech, a beech snag, and a hemlock. *Epifagus virginiana*, *Monotropa* spp., and *Corallorhiza maculata* occur on the hillside, but not near the single stem. In general, the steep slope does not have good leaf litter accumulation, with the exception of a few pockets, and there are few beech in the canopy or understory. Threats to the roadside population include: potential for flooding; roadside maintenance (including culvert work; brush cutting; and road sanding); stochastic events that could eliminate the small population, unknown impacts from herbivory; and largely unsuitable habitat. The roadside population is owned publicly by the Brattleboro Department of Public Works and the hillside is owned privately.

**VT .003 (Brookline)** -- This occurrence was first documented in 1981 when 13 plants were observed. Searches in 1995 and 1998 revealed no plants, but the searches were likely conducted at a slightly different location. In 2001, 13 stems were observed in a small woodlot scattered over approximately 1/2 acre. Stems were found in shallow depressions filled with leaf litter, especially in the vicinity of boulders. Tree species listed in 1981 (*Tsuga canadensis*, *Fagus grandifolia*, and *Acer rubrum*) remain dominant in 2001. Moisture conditions are mesic, light is filtered, aspect is south-southwest on a gentle slope (< 10%). Elevation is approximately 330 feet (100 meters). No associated herbaceous plants occur in the immediate vicinity of the orchid, but *Dennstaedtia punctilobula*, *Monotropa uniflora*, *Mitchella repens*, *Uvularia sessilifolia*, and *Arisaema triphyllum* grow nearby, as well as young beech saplings. Threats include small size of the population and habitat, unknown impacts of possible changes in canopy and habitat quality, and unknown future land uses.

**VT .004 (Fair Haven)** -- This occurrence was seen and documented only in 1842. The occurrence is considered historic.

**VT .005 (Newfane)** -- This site was initially documented in 1897 in hollows of cradle knolls in beech woods; a few plants were present. It was last seen in 1898. The occurrence is considered historic.

**VT .007 (Westminster)** -- This occurrence was seen and documented only in 1899 (one plant on a rotten stump). The occurrence is considered historic.

**VT New EO (Dummerston)** -- This occurrence was first documented in 2001, and in terms of population vigor, habitat quality, and present level of protection, it is the state's best quality occurrence. The site is a largely deciduous forest with *Fagus grandifolia*, *Betula lenta*, *Quercus rubra*, *Acer rubrum*, *Tsuga canadensis*, and *Betula papyrifera* present. Plants occur on a south-southwest facing, 10-20% slope with dry-mesic moisture conditions. Elevation is approximately 425 feet (129 meters). Light is filtered. The substrate is granitic with numerous, large granitic boulders present. Few herbaceous plants grow in the immediate vicinity of the orchid (although several patches of orchid stems are growing up through ferns); nearby associated species include *Dennstaedtia punctilobula*, *Epifagus virginiana*, *Monotropa uniflora*, and beech and white pine seedlings. The orchids generally grow in shallow depressions filled with leaf litter and are especially found near boulders. One stem was found growing on a trail. Threats include possible competition from *D. punctilobula*, potential canopy and understory changes, and inadvertent trampling and disturbance from hikers and from surveying activities.

### **Status of Massachusetts occurrences**

Massachusetts has three current occurrences, but one of these consisted of two plants and was last documented in 1981. The site is privately owned. A second current occurrence consisted of approximately 700-800 stems in 2000. The population has been well-studied over a number of years and has exhibited significant fluctuations, but the number of stems has consistently been in the hundreds. The site is owned privately by a corporation. The third current occurrence was discovered in 2000 and consists of about 35 stems (with more likely in suitable habitat not yet searched); the site is privately owned. There are two historic occurrences documented; ownership of the historic sites is unknown.

**MA .001 (Greenfield)** -- This occurrence is in a mesic beech and hemlock woods on an east facing midslope (0-20 degrees). Light conditions are shaded, and the soil is likely acidic. Elevation is about 300 feet (91 meters). Canopy species include *Fagus grandifolia*, *Tsuga canadensis*, *Acer saccharum*, and *Ostrya virginiana*. Associated species include *Epifagus virginiana*, *Maianthemum canadense*, *Monotropa uniflora*, and *Vitis* sp. The occurrence was seen and documented in 1981 only. At that time, only two plants were found in a leaf-lined depression. In 1981, threats included: stochastic events that could eliminate the small population; potential development; and timber harvest. An undocumented visit after 1981 by a person familiar with the taxon revealed no plants at the site. The occurrence may be extirpated.

**MA .003 (Deerfield)** -- This occurrence was seen and documented only in 1913. The occurrence is considered historic.

**MA .004 (Rowe)** -- This occurrence is in a relatively rich mesic forest on a steep south facing midslope (20-75 degrees). Light conditions are shaded. Elevation ranges from 820 to 900 feet (250-274 meters). Dominant tree species include *Fagus grandifolia*, *Acer saccharum*, *A. pensylvanicum*, *Fraxinus americana*, *Betula lenta*, and *Tilia americana*. The orchid grows in or near small hollows lined with leaves. Associated herbaceous species include *Polystichum acrostichoides*, *Aster divaricatus*, *Arisaema triphyllum*, *Viola rotundifolia*, *Monotropa uniflora*, *Tiarella* sp., and *Epifagus virginiana*. The occurrence was first documented in 1986 with 260 plants found. The population was monitored in detail each year from 1988-1996; a brief visit was made in 2000 also. Population numbers have fluctuated over the years, although some differences are due to the discovery of new plants: 1988 (373 plants), 1989 (100 plants), 1990 (180 plants), 1991 (365 plants), 1992 (430 plants), 1993 (433 plants), 1994 (1471 plants), 1995 (971 plants), and 1996 (1338 plants), and 2000 (700-800 plants estimated). A private corporation owns the site, and the occurrence is included in a 1992 management agreement. Threats

include: unknown impacts of herbivory; possible changes as forest mature; and localized impacts of grapevine falls.

**MA .005 (Conway)** -- This occurrence was seen and documented only in 1928. The population is considered historic.

**MA .006 (Florida)** -- This occurrence, discovered in 2000, is in a mesic, beech-dominated forest on a 0-45% mid-slope. Light conditions are shaded. Elevation is about 1200 feet (366 meters). Thirty-five stems were counted in an area of about 0.25 acre (1012 square meters). Plants grow in leaf litter deposits in hollows and along logging paths. A private individual owns the site and has expressed interest in selling the land for conservation purposes. No identified threats were identified, but the population may be affected by forest recovery after a blowdown and selective logging.

### **Status of Connecticut occurrences**

Connecticut has no extant populations; the plant was last seen in the state in 1920. There are three historic occurrences documented by the Natural Heritage Program, and several other locations according to herbarium records. Little additional information exists for the historic occurrences; the habitat for two sites was described as hemlock woods and rocky woods.

**CT .001 (New Haven)** -- This occurrence was seen and documented only in 1879 in rich hemlock woods. The occurrence is considered historic.

**CT .002 (Southington)** -- This occurrence was initially documented in 1906 in rocky woods near a lake and last seen in 1920. The occurrence is considered historic.

**CT .003 (Norwich)** -- This occurrence has no documentation date associated with it. The occurrence is considered historic.

### **Current Conservation Measures in New England**

Current conservation measures that potentially protect *Triphora trianthophora* in New England include protection under state endangered species legislation, site ownership by entities that may act to protect the species, management to protect a portion of a population from the impacts of timber harvest, and regular monitoring of a number of occurrences.

### **State Endangered Species Legislation**

In Maine, *Triphora trianthophora* is listed as a threatened species and is protected under Maine Revised Statutes Annotated 5 MSRA C, 383, sub C. III, articles 1-A. In New Hampshire, *T. trianthophora* is listed as a threatened species and is protected under the 1987 State law RSA 217-A:3, III. In Vermont, *T. trianthophora* is listed as a threatened species and is protected under the 1981 Vermont Endangered Species Law 10 V.S.A. Chapter 123. In Massachusetts, *T. trianthophora* is listed as an endangered species and is protected under the 1992 Massachusetts Endangered Species Act, MGL c. 131A and its regulations, 321 CMR 10.00. In Connecticut, *T. trianthophora* is listed as a species of special concern that is extirpated from the state, and is protected under Public Act 89-224. While *T. trianthophora* receives legal protection in these New England states, the scope of protection provided by the legislation is limited. State endangered species acts typically

prohibit the direct taking of listed species but do not prohibit taking that is incidental to and not the purpose of carrying out an otherwise lawful act. For example, in Vermont the legislation does not address threats such as land use that are incompatible with the well being of the plant unless the plant itself is taken. Also, permitting processes exist that can allow for the taking of individuals of listed taxa under certain circumstances.

### **Site Ownership**

Conservation of *Triphora trianthophora* occurrences may result from site ownership by private or public entities that act to protect the plant. There are six occurrences in Maine and New Hampshire found on White Mountain National Forest land. The Forest Service is aware of these occurrences, and endeavors to protect listed species such as *T. trianthophora*. Several occurrences are on land owned by private individuals. One is owned by corporation with interests in the conservation of the species and its habitat, and another by a town potentially willing to accommodate the species. One site in Vermont is owned by a private conservation organization. Approximately half of the current occurrences of *T. trianthophora* in New England are on privately owned land with no formal or informal conservation measures in place.

### **Management**

One portion of an occurrence in the White Mountain National Forest was protected from a timber harvest conducted at the site. Data will be collected over several years to assess impacts of timber harvest on *Triphora trianthophora*. No other management activities are known for *T. trianthophora* in New England. Various management suggestions have included canopy thinning, preventing timber harvest, rerouting trails and woods roads, preventing development, and modifying roadside maintenance activities.

### **Monitoring**

Although monitoring of populations is not a conservation measure in itself, it is essential for establishing the current status of populations and to assess population trends. It is also a prerequisite to implementation of management activities. In the past 20 years, approximately one-third of the current New England occurrences have been monitored for Natural Heritage Programs as many as four times, but the monitoring intervals are not consistent.

### **Conservation Objectives for the Taxon in New England**

Four conservation objectives are proposed for *Triphora trianthophora* to ensure its persistence in New England during the next 20 years. The first objective is to maintain, at a minimum, the existing number of occurrences at their current population levels. The second objective is to search for previously undocumented occurrences and to protect newly found populations when possible. The third objective is to identify and protect promising habitat that is apparently unoccupied by the orchid currently. The fourth objective is to evaluate the possibility of augmentation, reintroduction, and introduction of the orchid. Specifically, the result of achieving the above objectives should be the presence of 20 protected occurrences. At least half of the occurrences should have greater than 100 stems present aboveground in any given year (or another similar threshold value that is established). Although 100 stems is perhaps an arbitrary and conservative threshold for extreme concern for populations, the four current populations that may now be extirpated (ME .006, VT .001, VT .002, and MA .001) had fewer than 20 stems present at their most recent survey. It is prudent maintain populations above thresholds from which populations may not recover.

A discussion of the rationale for developing these four conservation objectives for *Triphora trianthophora* follows. First, the most effective way to ensure the long-term viability of plant species is to protect large numbers of healthy populations in natural habitat; protecting the remaining *T. trianthophora* occurrences through the first objective is essential to this effort. Second, *T. trianthophora* is represented in New England by 24 occurrences, a relatively low number. Furthermore, three of these occurrences are possibly extirpated based on recent field observations (ME .006 [Stow], VT .001 [Dummerston], and MA .001 [Greenfield]). Five additional occurrences had fewer than 50 stems found at the most recent surveys (ME .004 [Hiram], NH .001 [Madison], NH .002 [Conway], VT .002 [Brattleboro], and VT .003 [Brookline]). Only ten occurrences had greater than 100 stems present at the most recent surveys (ME .001 [Stow], ME .005 [Raymond], ME .007 [Parsonfield], NH .003 [Madison], NH .004 [Wakefield], NH .005 [Albany], NH .006 [Holderness], NH .021 [Albany], VT .008 [Dummerston], and MA .004 [Rowe]). The number of known and protected occurrences should include a minimum of 20 protected occurrences.

The second objective of searching for previously unknown populations will help to increase the number of known occurrences. Twenty occurrences would be approximately half of the combined total of 42 historic and current occurrences reported, and this figure represents the threshold number of occurrences for a NEPCoP Division 2 plant species (Brumback and Mehrhoff *et al.* 1996). Small populations of *T. trianthophora* are more susceptible to extirpation than are larger populations; as mentioned previously, several smaller current populations are probably extirpated. Thus, it is important to conserve a significant number of populations (approximately half of the occurrences) with at least 100 stems present in any given year. Long-term conservation of *T. trianthophora* in New England will likely require the persistence of a minimum of 20 occurrences and the presence of a minimum of 10 with greater than 100 stems present.

Third, although protection of apparently unoccupied habitat might be viewed as a low priority compared with the substantial protection needs of known populations, it is a high priority for this taxon because plants may actually be present in the form of underground tuberoids.

Fourth, while augmentation, introduction, or reintroduction of *T. trianthophora* are not presently recommended, it is prudent to explore the desirability and feasibility of such actions now so that information will be available to inform future decisions.

Determination of the number of populations, their size, and their distribution required for successful conservation of any taxon is clearly a subjective and dynamic endeavor. The conservation objectives and actions presented here should be viewed as initial recommendations that will be modified as a new information becomes available and is evaluated.

### **General Conservation Actions for the Taxon**

General conservation actions for threatened and endangered plant taxa typically include the following actions: land acquisition or protection; regular surveys of known occurrences; *de novo* searches for new populations; species biology research; habitat or site management; *ex-situ* activities including seed banking; germination research and propagation; reintroduction including augmentation, introduction, and reintroduction; and education of landowners and the public. These general conservation actions are discussed below with particular reference to *Triphora trianthophora* in New England. Any preliminary work necessary to support the

conservation actions and a proposed general chronology for initiating the conservation actions is presented as well.

### **Land acquisition or protection of occurrences**

A conservation strategy focusing on protection of existing populations is likely to be the most successful strategy from a biological standpoint. Land acquisition by entities that protect *T. trianthophora* will aid substantially in conserving the taxon. Similarly, protection of occurrences by current landowners will aid in conservation. Acquisition and protection of occurrences can prevent/minimize threats such as development and incompatible timber harvest activities. Priority sites include: ME .001 [Stow]; ME .005 [Raymond]; ME .007 [Parsonfield]; NH .005 [Albany]; NH .006 [Holderness]; NH .021 [Albany]; VT .002 [Brattleboro]; MA .004 [Rowe]; and MA .006 [Florida]. These priority sites are occurrences of especially high quality in terms of population size and habitat quality, ones faced with imminent threats, and/or occurrences in states that have few current occurrences. Preliminary steps to acquisition and protection will be site specific but may include: determining land ownership; talking with landowners; and research to determine appropriate management practices. This conservation action helps to meet all four conservation objectives.

In addition to the protection of known occurrences, the protection of potential habitat is important in the conservation of *Triphora trianthophora* because apparently unoccupied habitat may actually contain tuberoids. Additionally, such habitat can accommodate changes that occur both in ecological and in evolutionary time. At many sites, suitable habitat appears to exist with no aboveground plants currently present. Such areas of apparently suitable habitat are important to protect in the event of extirpation of currently known occurrences. For example although no aboveground stems were observed over a six-year period in certain localities at one site, underground tuberoids were nonetheless present in the soil (Williams 1994). Preliminary work with regard to this action includes: identifying occurrences that are likely to have potential habitat nearby based on habitat characteristics typical for the orchid; discussing with knowledgeable persons what areas may be good candidates, both biologically and logistically, for protection; determining ownership of potential habitat both for purposes of landowner permission and likelihood of protection; determining likelihood of protection through discussions with landowners. Acquisition and protection of promising habitat apparently unoccupied by the orchid supports the second, third, and fourth objectives.

### **Regular surveys (and inventories) of known occurrences**

An understanding of population levels and fluctuations is fundamental to conserving the taxon. Regular surveys help to develop an understanding of the orchid's natural population fluctuations (Williams 1994) and can be used to assess population responses to anthropogenic activities and natural disturbances. Additionally, without regular monitoring, it would be impossible to assess the success or failure of any management practices implemented. However, because the plant may exist as an underground tuberoid for extended periods of time, it is impossible to assess the true population size; counts will reveal only the number of aboveground stems produced. An important preliminary step in carrying out this action is to develop a consistent and minimum-impact monitoring technique for estimating population size to be used at all sites. Consultation with researchers familiar with the species will be helpful in this regard. A proposed method is to count stems and approximate the area encompassing the plants. Although time consuming, precise mapping of the occurrences would be useful. However, if there is danger of damage to the plants and/or disruption of the habitat, an overview of populations from the edges of the occurrence may be necessary. Also, for sites with a large number of stems and/or large acreages, sampling of a subset of the plants and area may be necessary. The use of photography

with benchmarks may be useful as well. More detailed demographic studies focusing on dormancy and survival have been done for other orchid species (Shefferson et al. 2001) and may be appropriate for *Triphora* as well if they can be completed without injuring individuals or habitat. In general, monitoring should occur every three years and more frequently if threats are imminent. This conservation action helps to meet the first and second conservation objectives.

### **De novo searches for new populations**

The discovery of new populations and the subsequent protection of these occurrences will be of great benefit in increasing the number of known, protected populations. One discovery of a previously unknown population was made in 2000 in Massachusetts, and another was made in 2001 in Vermont. Searches should take place near known occurrences and in other likely habitat. Although orchids are well-studied in general, *T. trianthophora's* cryptic nature makes it elusive, and it may have been overlooked. Several occurrences of *T. trianthophora* have been found relatively recently in Maine (Eastman 1969; Eastman 1972), Louisiana (Holmes 1980), Virginia (Ogle 1975), and South Carolina (Porcher 1977). Preliminary steps in searching for new populations include: identifying likely potential areas based on investigation of areas near current and historic occurrences and talking with persons familiar with taxon who may know of other likely areas to search. Techniques such as computerized habitat modeling may lead to the discovery of new populations as it did for another rare orchid in the northeast (Sperduto 1995). This conservation action helps to meet the second conservation objective.

### **Species biology research**

An understanding of certain elements of the taxon's biology is important in conservation efforts. Specifically, determining optimal and acceptable light, moisture, and leaf litter and soil conditions will allow for appropriate management decisions to be made. Paired comparisons of beech-dominated sites that do and do not support *Triphora trianthophora* may be informative. Although impacts from timber harvest are generally viewed as negative for forest herbs, comments in Natural Heritage Program data bases suggest that canopy thinning may be appropriate in conditions that are thought to be too shaded. Additionally, there are several comments in the data bases suggesting that opening up the canopy through timber harvest may benefit the species and its habitat. Precise light requirements for the orchid are unknown. However, many of the best sites occur in mature beech forests. Many other aspects of the biology of *T. trianthophora* are of interest and potentially important in management of the species; these include: mycorrhizal and saprophytic relationships; pollination; seedling establishment; vegetative reproduction; genetic diversity; and impacts of herbivory. However, research in these areas is not likely to be crucial to management decisions and/or the research may prove too difficult to conduct in a non-destructive fashion. Because mycorrhizal associations are likely to be crucial to the existence of the orchid, they should be considered for study; studies on other orchids may provide insights as to the importance of additional information for management and the costs to populations of conducting such research (Taylor and Bruns 1997 and Kristiansen 2000). Woody debris is also known to be important for seed germination in certain orchid species (Rasmussen and Whigham 1998). This conservation action helps to meet all four conservation objectives.

### **Habitat or site management**

As mentioned above, the precise requirements of the species are unknown, but likely management includes: developing timber harvest plans that are compatible with the conservation of the species or restricting timber

harvest in certain circumstances; canopy thinning to favor beech; promoting soil and leaf litter conditions conducive to healthy populations; actions such as rerouting trails and woods roads; undertaking compatible roadside management activities; and planning development appropriately. A thorough, nation-wide investigation of management practices that have been employed in the conservation of *T. trianthophora* as well as discussions with knowledgeable persons in New England are necessary. Of particular interest are efforts related to providing an ideal light, moisture, and litter environment (such as canopy thinning and appropriate timber management plans). Proposals for habitat and site management will be dependent on adequate knowledge of the taxon's biology. This conservation action helps to meet all four conservation objectives.

### **Ex-situ activities including seed banking, germination research, and propagation**

These activities would be essential if any future reintroduction efforts were to take place. However, the desirability and feasibility of reintroduction and *ex-situ* activities for the taxon are unclear. Typically, orchids are difficult to propagate via seed or vegetative parts. Additionally, *T. trianthophora* produces capsules infrequently. Blanchard (1902) states that artificial propagation of bulbs (tuberoids) might be successful. Correll (1950) notes that the orchid was introduced into England around 1824 and that the plants subsequently flowered. It is possible (but not necessarily advisable) that tubers could be transplanted successfully (Sue Williams, consulting botanist, personal communication). Luer (1975) eloquently cautions against any attempts, likely to be unsuccessful in the long-term, to transplant native orchid species. *Ex-situ* activities help to meet the fourth conservation objective; any *ex-situ* activities should be engaged in conservatively as suggested below.

### **Augmentation, introduction, and reintroduction**

As a theoretical conservation measure, it could be beneficial re-introduce the orchid into some areas of its historical occurrence, introduce it to suitable, nearby habitat, and augment small populations. Despite the theoretical benefit of such restoration efforts, there are potential detrimental effects and substantial obstacles associated with restoration efforts. These include altering the genetic makeup of populations, disruption of habitat, the potential for introduction of disease, the intensive management required for such efforts, and the general lack of success in transplanting or seeding orchids. As mentioned above, reintroduction hinges on successful *ex-situ* activities, and these are dubious for the taxon. Questions regarding the desirability and feasibility of reintroduction must be addressed before embarking on reintroduction efforts.

Because of the substantial concerns regarding augmentation, introduction, and re-introduction, these actions are not recommended at the present time. However, a group of experts should explore issues related to the actions, and background information should be gathered in the event that the actions become necessary in the future. Investigation of augmentation, introduction, and reintroduction should include: determining if augmentation, introduction, and reintroduction are desirable through discussions among experts on the taxon, state Natural Heritage Programs, NEWFS, and landowners; determining if there is a source of tuberoids that will not compromise the well-being of existing natural populations (if a portion of a population were going to be destroyed unavoidably, this would be a possible source of tuberoids that could be used in transplantation); determining if transplantation of tuberoids is possible by investigating if any successful transplantations have occurred and what methods have been used; determining areas likely for reintroduction if the above concerns are answered in the affirmative; looking in and around historic sites and likely habitat in their towns of occurrence for appropriate sites; determining if there are likely occurrences as sites for augmentation by identifying occurrences that have potential unoccupied habitat nearby; determining if artificial pollination

enhances seed production and establishment of individuals. This conservation action helps to meet the fourth conservation objective.

If it is determined that augmentation, introduction and/or reintroduction are desirable and if *ex-situ* propagation is successful, then these restoration efforts may help to ensure the conservation of the taxon. This would be important in Connecticut where the taxon has likely been extirpated and in states where there are few known extant populations: Vermont (one occurrence) and Massachusetts (three occurrences). Augmentation could expand the spatial coverage of the orchid at appropriate sites and reduce the risk of extirpation of the orchid through random events. In many cases, the plant is restricted to a small area and is represented by few individuals, and there is potentially suitable habitat nearby. If augmentation were to occur in the future, the focus should be on smaller populations with fewer than 50 aboveground stems present. If this action were taken, augmentation should occur at a single locality until the results and consequences are known.

### **Education of landowners and the public**

Knowledge of the taxon and its conservation needs on the part of landowners and the public is essential in developing a successful conservation strategy. Information about the taxon can help to guide activities such as development, timber harvest, recreation, and road maintenance. Education that helps to ensure the persistence of the species should be available to landowners, individuals who use lands on which the taxon occurs, researchers, botanists (amateur and professional), and those carrying out activities that may affect the taxon. The benefits of educational efforts must be balanced carefully with the benefits of maintaining the confidentiality of details of the populations. This conservation action helps to meet all four conservation objectives.

A general chronology for meeting the conservation needs of *Triphora trianthophora* in New England can be based primarily on prioritization of the stated conservation objectives. As discussed in this section, there are a number of instances in which preliminary work needs to be completed before the conservation actions supporting the conservative objectives can be carried out.

The first objective, to maintain the existing number of occurrences at current population levels, is the most important objective in conserving *T. trianthophora* and should receive immediate attention. The conservation actions that support this objective are: land acquisition and protection of occurrences; education; regular surveys; management; and species biology research.

The second objective, to search for previously undocumented occurrences and to provide protection for newly discovered populations, is the second most important objective. Conservation actions that support this second objective include *de novo* searches for new populations and the actions listed above for the first objective.

The third objective, to identify and protect promising habitat that is apparently unoccupied by the orchid, is the next most important objective. While this third objective is important in a long-term conservation strategy for *T. trianthophora*, the objective will be difficult to achieve and is likely less important than the first two objectives in conserving the orchid. Conservation actions required to meet this objective initially include: education; land acquisition; and species biology research.

The final objective, to evaluate the possibility of augmentation, introduction, and reintroduction, is the lowest priority objective. Conservation actions required to meet this objective include the preliminary work discussed previously and *ex-situ* activities.

This general chronology should be viewed as a basic framework for the order or priority for carrying out the conservation objectives and actions. However, it is likely that implementation will reveal complexities in the order in which work should be completed. Many of the conservation actions are interdependent and difficult to carry out in isolation of one another. For example, protection of occurrences may be dependent on management, which is ultimately dependent on species biology research. It would be difficult to suggest a general chronology for carrying out these actions that could be applied to all occurrences.

### **Recommended Conservation Actions for Each Occurrence**

The following section describes recommended conservation actions for each *Triphora trianthophora* occurrence in New England. The actions are designed to meet the conservation objectives discussed previously. The implementation of these actions will require conservation funds and personnel beyond those available currently for threatened and endangered plants in New England. As the phrase suggests, these recommended conservation actions should be viewed as recommendations and should be modified to best ensure the conservation of *T. trianthophora* in New England.

#### **Maine**

**ME .001 (Stow)** -- Develop a site management plan with WMNF (especially with regard to timber harvest, trail location, and canopy closure). Monitor population and habitat every three years. Identify and protect suitable habitat that is apparently unoccupied. Determine education strategy for forest users. Include site in study of relationship between orchid viability and light, moisture, and leaf litter conditions.

**ME .002 (Stow)** -- Revisit to determine if still extant; if extant, monitor and develop a site management plan with WMNF.

**ME .003 (Stoneham)** -- Develop a site management plan with WMNF. Monitor population and habitat every three years (especially to determine course of recovery after severe ice storm damage). Determine extent of population. Identify and protect suitable habitat that is apparently currently unoccupied. Determine if taxon is on private land as well as Forest Service land.

**ME .004 (Hiram)** -- Revisit to determine current status of population. Discuss possible conservation measures with landowners; they have expressed an interest in conserving the orchid. Monitor population and habitat every three years.

**ME .005 (Raymond)** -- Determine all landowners and discuss conservation measures with landowners (especially impacts of path, campfire wood collection, and potential development). Monitor population and habitat every two years. Determine education strategy for landowners and land users. Include site in study of relationship between orchid viability and light, moisture, and leaf litter conditions.

**ME .006 (Stow)** -- Determine if population is still extant; pursue protection if it is extant.

**ME .007 (Parsonfield)** -- Monitor population and habitat every three years (especially plants' response to succession after heavy cutting in the 1980s). Landowners will likely carry out yearly monitoring; they are knowledgeable and concerned about well being of the orchid. Map extent of occurrence. Identify and protect suitable habitat that is apparently currently unoccupied. Discuss management strategies with landowners. Include site in study of relationship between orchid viability and light, moisture, and leaf litter conditions.

## **New Hampshire**

**NH .001(Madison)** -- Determine ownership. Develop management plan with owners. Monitor population and habitat every three years (especially with regard to ice storm damage and timber harvest).

**NH .002 (Conway)** -- Determine ownership. Revisit to determine if population is still extant; if extant, monitor and develop site management plan with owners.

**NH .003 (Madison)** -- Determine ownership. Discuss protection options with owners. Monitor population and habitat every three years. Identify and protect suitable habitat that is apparently currently unoccupied by plants. Include site in study of relationship between orchid viability and light, moisture, and leaf litter conditions.

**NH .004 (Wakefield)** -- Discuss protection options with landowners. Monitor population and habitat every three years. Identify and protect suitable habitat that is apparently currently unoccupied by plants. Include site in study of relationship between orchid viability and light, moisture, and leaf litter conditions.

**NH .005 (Albany)** -- This is an excellent population in natural habitat, but the area could be developed or harvested for timber; protection is a high priority. Work with landowners to achieve protection. Acquisition of land or an easement would be ideal; the site is adjacent to White Mountain National Forest Land. Monitor population and habitat every three years. Identify and protect suitable habitat that is apparently currently unoccupied. Include site in study of relationship between orchid viability and light, moisture, and leaf litter conditions.

**NH .006 (Holderness)** -- Landowner is aware of population and interested in its conservation; encourage protection by landowner (especially with regard to future potential timber harvest and development plans). Work with town to reduce impacts of roadside maintenance. Monitor population and habitat every three years. Determine extent of population. Contact individual (Philip Keenan) who has monitored and studied the population for years for ideas on conservation and management. Include site in study of relationship between orchid viability and light, moisture, and leaf litter conditions.

**NH .007 (Tamworth), NH .008 (Laconia), NH .009 (Meredith), and NH .010 (Tamworth)** -- These are considered historic populations. A few of these occurrences and likely habitat nearby should be explored to see if any of these occurrences are still extant. Reintroduction into some of these areas should be evaluated.

**NH .011 (Chatham)** -- Revisit to determine if population is still extant; if extant, monitor and develop a site management plan with WMNF.

**NH .012 (Holderness), NH 013 (Winchester), and NH .014 (Hillsborough)** -- These are considered historic populations. A few of these occurrences and likely habitat nearby should be explored to see if any of these occurrences are still extant. Reintroduction into some of these areas should be evaluated.

**NH .015 (Chatham)** -- Revisit to collect more information on the ecology of the population and its status; original visit focused on forests in the area and not on the plant. Develop a site management plan with WMNF. Monitor population and habitat every three years.

**NH .016 (Conway), NH .017 (Hillsborough), NH .018 (Bartlett), and NH .019 (Holderness)** -- These are considered historic populations. A few of these occurrences and likely habitat nearby should be explored to see if any of these occurrences are still extant. Reintroduction into some of these areas should be evaluated.

**NH .020 (Sandwich)** -- Discuss protection measures with landowners; owners are cooperative and expressed an interest in a conservation easement in 1996. Revisit to determine population size. Monitor every three years. Explore possible management (canopy thinning).

**NH .021 (Albany)** -- This is an excellent potential population and protection is a priority. Many plants were found in an area of a heavy selective cut. Part of the area was set aside and left uncut to protect plants, but many plants were found in the cutover area. Determine current monitoring procedures. Determine extent of population. Determine ownership of adjacent land containing plants. Develop a site management plan with WMNF and adjacent landowner if appropriate. Restrict further cutting. Monitor yearly to assess impacts of heavy cutting. Include site in study of relationship between orchid viability and light, moisture, and leaf litter conditions.

## **Vermont**

**VT .001 (Dummerston)** -- This area has been searched to no avail four times in the last nine years. There is potential habitat (although not ideal habitat), so it is worth another try. Search again while nearby VT .002 is in bloom. Identify potential habitat that is of high quality for the possibility of protection.

**VT .002 (Brattleboro)** -- This is one of three Vermont occurrences seen since the early 1980s, and is a high priority for protection. Contact town and ensure that population will not be impacted as a result of road maintenance. Monitor yearly. One stem was found on hillside; landowner should be contacted to explore protection possibilities and another search should be carried out to see if more can be found. Identify and protect suitable habitat that is apparently currently unoccupied. Possible management to reduce soil slippage and to encourage development of deep leaf litter; selective cutting to encourage beech. These management activities should take place only after obtaining information suggesting that such management is likely to be beneficial and unlikely to be detrimental. Include site in study of relationship between orchid viability and light, moisture, and leaf litter conditions.

**VT .003 (Brookline)** -- This is a small site that has good quality habitat. Only 13 stems were found in 2001 in the area searched, but it was a dry year and more stems may emerge in more favorable years. There may be additional habitat nearby in addition to the approximately 1/2 acre searched. Discuss protection options with landowner. Re-survey to attempt to find additional stems and habitat; monitor every three years. Include site in study of relationship between light, moisture, and leaf litter conditions and orchid viability.

**VT .004 (Fair Haven), VT .005 (Newfane), and VT .007 (Westminster)** -- These are considered historic populations and are likely extirpated. Because there is only a single (very threatened) extant population in Vermont, some select suitable habitat in the three towns should be investigated for the possibility of extant populations and evaluated for the possibility of reintroduction.

**VT New EO (Dummerston)** -- This site was first documented in 2001. In terms of population vigor, habitat quality, and level of protection, it is the best occurrence known in Vermont. The site should be a high priority for protection. Recommended conservation actions include: evaluating the possibility of removing competing understory vegetation in some areas; considering trail relocation (contact landowner/manager to discuss both of these); determining extent of likely habitat on the parcel where the orchid is located and on adjacent privately owned land; re-surveying to determine if additional stems can be found; monitoring every three years; including the site in a study of the relationship between orchid viability and light, moisture, and leaf litter conditions.

## **Massachusetts**

**MA .001 (Greenfield)** -- Permission to visit the site in 2000 was denied by the landowner. Attempt again to get permission to revisit site and surrounding area to determine if population is still extant. If extant, discuss possible conservation measures with landowner and monitor.

**MA .003 (Deerfield) and MA .005 (Conway)** -- These are considered historic occurrences. Suitable habitat should be searched to see if any populations can be re-located. Evaluate possibility of reintroduction.

**MA .004 (Rowe)** -- This is one of the best populations in New England and should be protected by whatever means possible. Develop a long-term management plan with corporate landowner (has been cooperative and no imminent threats; a 1992 cooperative management agreement exists). Monitor every three years. Include site in study of relationship between orchid viability and light, moisture, and leaf litter conditions.

**MA .006 (Florida)** -- This is a newly discovered population with substantial potential habitat nearby. Revisit to determine extent and size of population in 2001. Pursue protection measures with landowners. Monitor every three years.

## **Connecticut**

**CT .001 (New Haven), CT .002 (Hartford), and CT .003 (New London)** -- These are considered historic populations. Some select suitable habitat in the three towns should be investigated for the possibility of extant populations and evaluated for the possibility of re-introduction

## **Prioritized implementation table**

The prioritized implementation table that follows (Table 3) lists and ranks actions that should be undertaken in order to implement the conservation plan for *Triphora trianthophora*. The schedule is subject to revision based on annual review of conservation objectives. Conservation actions are arranged in priority order based on the following definitions:

Priority 1 – An action that should be taken to prevent irreversible declines in the species' status in New England.

Priority 2 – An action that should be taken to prevent or reverse significant declines in the species' status in New England.

Priority 3 and 4 – All other actions necessary to meet the conservation objectives.

As landowner contact is required for each site to gain site access and permission to perform other research activities, it is considered a priority action and will not be listed separately for each occurrence unless special circumstances exist. Conservation activities to follow assume landowner permission has been acquired.

The following descriptions are based on information obtained from state Natural Heritage programs, field visits by the author in 2000, and discussions with several persons knowledgeable about the occurrences. All available information from these sources is included for each occurrence.

### **Status of Maine occurrences**

Maine has seven current occurrences. Five of these populations were last seen between 1996 and 2000, and two populations were not seen when last visited in the 1990s. Reported population size ranges from only five stems to nearly 350 stems; only two occurrences had greater than 100 stems at the most recent surveys. Four of the occurrences exhibited possible declines, and most of the occurrences exhibited apparent fluctuations. However, population size is extremely difficult to assess. Two of the sites are publicly owned (White Mountain National Forest), one has public (White Mountain National Forest) and private ownership, and four sites are privately owned. There are no reported historic occurrences for Maine. There is an additional occurrence in the township of Brownfield (Frankie Brackley Tolman, consulting botanist, personal communication).

**ME .001 (Stow)** -- This occurrence is located in the White Mountain National Forest in a forest dominated by *Fagus grandifolia* on a southeast-facing rocky hillside (0-35% mid-slope). Moisture conditions are mesic to dry-mesic, and light conditions are filtered. Elevation ranges from 1050 to 1200 feet (320-366 meters). Soils are a sandy loam. In addition to *Fagus grandifolia*, other canopy species present include *Quercus rubra*, *Acer saccharum*, *Betula alleghaniensis*, *Ostrya virginiana* and *A. rubrum*. Prominent species in the understory include *A. pensylvanicum*, *O. virginiana*, and *A. rubrum*. *Triphora trianthophora* grows primarily in hollows filled with beech and oak leaf litter; the species tends to occur with few other species, but associated species growing nearby include *Epifagus virginiana*, *Uvularia sessilifolia*, *Maianthemum canadense*, *Mitchella repens*, *Gaultheria procumbens*, and *Monotropa uniflora*. In 2000, 97 stems were located; the population has fluctuated from 35 plants to hundreds of plants recorded. The occurrence was first recorded in 1969 and monitored again in 1970, 1976, 1989, 1991, 1997, and 2000. The most immediate threat to the occurrence is the proximity of numerous plants to a trail. Additional threats include impacts of herbivory, possible impacts of canopy closure, unknown impacts of light ice storm damage, and impacts of any future timber harvest.

**ME .002 (Stow)** -- This occurrence is located in the White Mountain National Forest. The site is a mature forest dominated by *Fagus grandifolia* with *Betula papyrifera*, *B. alleghaniensis*, *Quercus rubra*, and *Acer saccharum* occurring as well. The site was first reported in 1971 and visited again in 1976, 1984, 1989, and 1991. The occurrence is potentially a vigorous one; hundreds to a thousand plants were reported. However, no plants were found in 1991; hundreds of plants were reported in 1989.

**ME .003 (Stoneham)** -- This White Mountain National Forest site occurs in an enriched northern hardwood forest. The site is a south to southeast-facing mid to lower-slope (10-35%). Light conditions are filtered, and moisture conditions are mesic. Soils are a sandy loam with mica schist and numerous boulders present. Elevation ranges from 640 to 1300 feet (195-396 meters). Dominant tree species include *Fagus grandifolia*, *Quercus rubra*, *Acer rubrum*, *Populus grandidentata*, and *Betula papyrifera*. *Triphora trianthophora* grows

primarily in hollows filled with beech leaf litter; the species tends to occur with few other species, but associated species growing nearby include *Epifagus virginiana*, *Medeola virginiana*, *Monotropa uniflora*, *Gaultheria procumbens*, *Uvularia sessilifolia*, and *Clintonia borealis*. In 2000, 64 stems were located. The occurrence was first recorded in 1988 and visited again in 1989, 1991, 1997, and 2000. In the first two years of observation, thousands of plants were found. In 1991, no plants were found, and in 1997, 30 plants were found along a trail; a larger area was not searched. In 1989, the occurrence was described as an outstanding example with hundreds of plants in excellent quality habitat. In 2000, the population was much smaller, and the habitat was at least temporarily greatly diminished with respect to suitability for *T. trianthophora*. A recent ice storm caused substantial damage to the canopy and has led to very dense undergrowth in numerous locations and no evidence of *Triphora* stems. Additional threats to the occurrence include proximity of many plants to the trail and the potential for timber harvest.

**ME .004 (Hiram)** -- This occurrence is in a young beech-dominated forest on a rocky southeast-facing hillside (10-35% slope). The site is privately owned. Filtered light conditions and mesic moisture conditions exist. Soil is glacial till. The canopy is dominated by *Fagus grandifolia* with scattered *Pinus strobus*, *Quercus rubra*, *Acer saccharum* and *Betula papyrifera*. *Triphora trianthophora* grows primarily in hollows filled with beech leaf litter; the species tends to occur with few other species, but associated species growing nearby include *Epifagus virginiana*, *Monotropa uniflora*, and *Corallorhiza odontorhiza*. In 1996, 24 individuals were found and only two of these were reproductive. The occurrence was first documented in 1975 and monitored again in 1979, 1983, 1984, 1985, 1995, and 1996. On most occasions, tens of plants were found, on two occasions no plants were found, and on one occasion over a hundred plants were found. Threats include the potential for timber or firewood harvest, minor natural erosion on a steep slope and gully, and small population size.

**ME .005 (Raymond)** -- This occurrence is in a rocky beech forest on a west northwest-facing lower slope (0-10% slope). Light conditions are filtered and the moisture conditions are mesic. The soil is fine to medium sand, and there are numerous boulders present. Elevation is approximately 275 feet (84 meters). The canopy is dominated by *Fagus grandifolia* and *Tsuga canadensis*. *Hamamelis virginiana*, *Acer rubrum*, and *Quercus rubra* also occur. *Triphora trianthophora* grows primarily in hollows filled with beech leaf litter; the species tends to occur with few other species, but associated herbaceous species growing nearby include *Gaultheria procumbens*, *Medeola virginiana*, *Mitchella repens*, *Epifagus virginiana*, and *Corallorhiza maculata*. In 2000, approximately 230 stems were located. The population appears to have fluctuated since it was first documented in 1977 with greater than 200 individuals; in 1984 six to 10 individuals were located, and in 1995, 86 individuals were found. Threats to the occurrence include its proximity to a commercial recreational area (trampling that may result from use of a walking path and firewood collection, powerline maintenance, and potential development). The general area is fairly heavily used. Ownership is by a private company and private individual(s).

**ME .006 (Stow)** -- This occurrence was initially reported from a mixed hardwood forest dominated by beech on a dry rocky hillside. Elevation is approximately 600 feet (183 meters). The occurrence was first located in 1975 when 15 stems were found; subsequent attempts to locate the plant in 1994 and 1995 were unsuccessful. According to the most recent surveyor, a portion of the area in which the plants occurred is now cut and manicured. Associated species regenerating in the area include *Viburnum alnifolium*, *Betula papyrifera*, *Fagus grandifolia*, and *Acer pensylvanicum* and ground cover is much thicker than is typical for other sites. The population of *Triphora trianthophora* may now be extirpated at this site.

**ME .007 (Parsonfield)** -- This occurrence is located in an open beech woods with substantial leaf litter and in a young woods growing back after a very heavy cut. Plants occur midslope on a south southeast facing slope (0-35%). Soil is a very stony fine sandy loam. Elevation is approximately 600-700 feet (183-213 meters). The canopy is dominated by *Fagus grandifolia*, *Betula papyrifera*, and *Tsuga canadensis*. Few associated herbaceous or shrubby species occur in the more mature beech forest; *Rubus alleghaniensis*, *Rubus idaeus*, *Dennstaedtia punctilobula*, *F. grandifolia*, *Betula papyrifera* saplings and *Hamamelis virginiana* and *Acer pensylvanicum* occur in the area growing back after the cut. About half of the plants occur in the open beech woods in heavy beech leaf litter in small hollows; the other half occur in the recently cut area. When first reported in 1995, there were over 200 plants. In 1996, 415 individuals were reported, 225 in 1997, 500 in 1999, and 346 in 2000. Knowledgeable and conservation-minded individuals own the site; they first located the plant and monitor it regularly. Threats include unknown impacts of succession in young woods and damage from unknown insects.

### Status of New Hampshire occurrences

New Hampshire has 10 current occurrences. Eight of these populations were last seen between 1992 and 2000. Two populations were last seen in the late 1970s and early 1980s. There are also several occurrences known in New Hampshire that have not been officially reported to the Natural Heritage Program. There are 11 historic occurrences. Population sizes for current occurrences are two with 15 or fewer stems; one with 70 stems; four with 100-259 stems; one with over 400 stems; and two with no information. For current populations, four exhibit possible declines, one a possible increase, three exhibit apparent fluctuations, and trends for the others are unknown. Five of the sites are privately owned, three are publicly owned (White Mountain National Forest), and ownership of two sites is unknown. Ownership of the historic sites is unknown. There may be an additional occurrence in Holderness or an incorrect first observation date on the Holderness occurrence listed (Frankie Brackley Tolman, consulting botanist, personal communication) and two additional occurrences in Chatham (Sara Cairns [New Hampshire Natural Heritage Program] and Sarah Schwaegler [Consulting Botanist], personal communication).

**NH .001 (Madison)** -- This occurrence is in a beech-dominated northern dry-mesic to mesic hardwood forest. The site is on a gentle (12 degrees) southeast-facing slope with granitic bedrock and sandy loam soil with boulders. Partial light conditions exist. Elevation is 780 feet (238 meters). In addition to *Fagus grandifolia*, associated species include *Acer pensylvanicum*, *Aralia nudicaulis*, *Uvularia sessilifolia*, and *Epifagus virginiana*. The occurrence was first discovered in 1983 when between 51-100 plants were found, and was described as an excellent population. The population was monitored again in 1999 when only seven stems were found; the site was severely impacted by an ice storm and some cutting. Threats include unknown impacts of succession after an ice storm, potential of additional cutting (easily accessible in 1983 by well-maintained logging road), and stochastic events that could eliminate the small population. Ownership is unknown.

**NH .002 (Conway)** -- This occurrence is in a mesic northern hardwood forest. Plants grow on a west facing 10-35% lower slope. Bedrock is granitic, and soil is a sandy loam. Light conditions are shady. Elevation is 740-780 feet (225-238 meters). The forest consists of *Fagus grandifolia*, *Tsuga canadensis*, and *Quercus rubra*. The population was first documented in 1983; however, there are apparently older records for the site. It has not been documented since. 10-15 plants were discovered in 1983. Threats in 1983 included proximity to road, logging, development, and stochastic events that could eliminate the small population.

**NH .003 (Madison)** -- This occurrence is in a central New England mesic transitional forest. Plants grow on a south facing 10-35% slope on acidic bedrock and till; the plants are typically found in deep beech and oak leaf litter in small depressions. Light conditions are filtered to shaded. Elevation is about 800 feet (244 meters). Dominant tree species include *Quercus rubra*, *Fagus grandifolia*, *Pinus strobus*, and *Pinus resinosa*. Associated species include *Hamamelis virginiana*, *Viburnum* sp., *Acer pensylvanicum*, *Dennstaedtia punctilobula*, *Uvularia sessilifolia*, and beech and ash seedlings. In general, the site has more herbaceous and shrub cover than is typical of *Triphora trianthophora* sites. The orchid typically occurs at this site in hollows and where little else is growing. The occurrence was first documented in 1984 when 218 plants were found in a rough count; more plants likely occurred at the site. The site was resurveyed in 2000, and about 100 stems were found. Threats to the occurrence include: unknown impacts of past and potential timber harvest; proximity of some plants to road; trampling; competition from relatively dense understory; and stochastic events that could eliminate the relatively small population. Ownership is private, and the landowner is aware of the orchid and concerned about it.

**NH .004 (Wakefield)** -- This occurrence is in a central New England mesic transitional forest (oak-beech forest) on an east southeast-facing 15 degree slope. Bedrock is acidic, and soil is a sandy loam with cobbles and boulders. Light conditions are filtered to shaded. Elevation is approximately 750 feet (229 meters). Dominant tree species include *Fagus grandifolia*, *Betula lenta*, *B. papyrifera*, *Quercus rubra*, *Acer rubrum*, and *A. saccharum*; shrubs and herbaceous associated species at the site include *A. pensylvanicum*, *Hamamelis virginiana*, *Viburnum alnifolium*, *V. acerifolium*, *Epifagus virginiana*, *Monotropa uniflora*, and *Uvularia sessilifolia*. *Triphora trianthophora* grows primarily in hollows filled with beech leaf litter; the orchid is found at this site with no immediate associated species except a few beech seedlings. The occurrence was first documented in 1985 when 101-1000 plants were noted. The population was monitored again in 1987 (same status), 1992 (32 plants; monitored in October), 1993 (25 plants in a cursory search), 1999 (123 stems), and 2000 (approximately 100 stems). Ownership is private, and owners are aware of the orchid. Threats include: potential trampling (substantial trash in vicinity); unknown impacts of potential timber harvest (current logging in vicinity, but not in specific area where plants occur); and proximity of some plants to roadside.

**NH .005 (Albany)** -- This occurrence is in a mixed northern hardwood forest dominated by beech. Plants occur on a south facing dry-mesic midslope (8-15%). Soil is a sandy loam with large granitic boulders. Light is filtered. Elevation ranges from 740-800 feet (225-244 meters). Canopy species include *Fagus grandifolia*, *Quercus rubra*, *Populus grandidentata*, *Betula papyrifera*, and *Acer rubrum*. Ground cover is sparse at the site. *Triphora trianthophora* grows primarily in hollows filled with thick beech leaf litter. The species tends to occur with few other species, but associated herbaceous species growing nearby include *Gaultheria procumbens*, *Uvularia sessilifolia*, *Epifagus virginiana*, *Medeola virginiana*, *Maianthemum canadense*, *Monotropa uniflora*, *Vaccinium* spp., and *Aralia nudicaulis*. The occurrence was first documented in 1986 when hundreds of plants were found. In 1991, no plants were found, and in 1998, fewer than 50 plants were observed. In 2000, there were about 259 stems observed. This is an excellent site in terms of current undisturbed nature of habitat and population size and vigor. Threats include unknown impacts of any future timber harvest and potential development. The site is privately owned.

**NH .006 (Holderness)** -- This occurrence is in a dry-mesic to mesic beech forest. The site is gently north, northeast facing (0-3% slope). The light regime is filtered to shaded. Elevation ranges from 640-680 feet (640-680 meters). *Fagus grandifolia* dominates the canopy; other tree species include *Betula papyrifera*, *Picea rubens*, and *Acer pensylvanicum*. *Triphora trianthophora* grows primarily in hollows filled with thick beech leaf litter; the species tends to occur with few other species, but associated herbaceous species growing nearby include *Epifagus virginiana*, *Aralia nudicaulis*, *Gaultheria procumbens*, *Monotropa uniflora*, *Aster* sp., and

others. The occurrence was first documented in 1987 when over 5000 plants were found. In 1989, there were fewer plants, and in 1990, over 1000 plants were found. In 2000, 130 stems were located in a cursory search; there were likely many more. Threats include impacts of roadside brush cutting and other maintenance activities associated with the road, unknown impacts of potential timber harvest, unknown impacts of herbivory, and potential future development. The site is privately owned and the owners are aware of the plant and concerned about it.

**NH .007 (Tamworth)** -- This occurrence was initially documented in 1904 and last seen in 1915. The occurrence is considered historic.

**NH .008 (Laconia)** -- This occurrence was seen and documented only in 1901. The occurrence is considered historic.

**NH .009 (Meredith)** -- This occurrence was seen and documented only in 1903. The occurrence is considered historic.

**NH .010 (Tamworth)** -- This occurrence was initially documented in 1904 and last seen in 1940. The occurrence is considered historic.

**NH .011 (Chatham)** -- This occurrence is in a beech and oak forest on a southwest facing slope with plants growing in small hollows with beech leaf litter. Elevation is 1420 feet (433 meters). The occurrence was first documented in 1976, when several small colonies were located. In 1978, 70 plants were found, and in 1996, no plants were found. Aside from the relatively small population size, specific threats have not been identified. Ownership is public (White Mountain National Forest).

**NH .012 (Holderness)** -- This occurrence was seen and documented only in 1876. The occurrence is considered historic.

**NH .013 (Winchester)** -- This occurrence was seen and documented only in 1916. The occurrence is considered historic.

**NH .014 (Milford)** -- This occurrence was seen and documented only in 1899. The occurrence is considered historic.

**NH .015 (Chatham)** -- This occurrence was first documented in 1992 and apparently has not been revisited since that date. Information focuses on plant communities located in a relatively large area and does not provide detail on *Triphora trianthophora*. The site is in a mesic transitional forest at an elevation of about 700 feet (213 meters). Ownership is public (White Mountain National Forest).

**NH .016 (Conway)** -- This occurrence was initially documented in 1890 and last seen in 1905. The occurrence is considered historic.

**NH .017 (Hillsborough)** -- This occurrence was seen and documented only in 1909. The occurrence is considered historic.

**NH .018 (Bartlett)** -- This occurrence was seen and documented only in 1879. The occurrence is considered historic.

**NH .019 (Holderness)** -- This occurrence was seen and documented from a beech woods only in 1917. The occurrence is considered historic.

**NH .020 (Sandwich)** -- This occurrence is located in second-growth white pine-hemlock forest on a peninsula of a large lake. The site is on moist, shallow-to-bedrock soils on rocky, gently sloping ground. Elevation is 580 feet (177 meters). *Fagus grandifolia* and *Tsuga canadensis* are the dominant tree species with *Pinus strobus*, *Betula papyrifera*, and *Acer saccharum* occurring as well. The *Triphora trianthophora* population grows in a shallow, rocky depression with thick leaf litter about 200 feet upslope from shore. The population may be limited to a 20 square foot area (1.86 square meters). Associated herbaceous species include *Epifagus virginiana*, *Pyrola* sp., and *Gaultheria procumbens*. The occurrence was initially documented in 1996 and apparently has not been revisited. Threats to the occurrence include small apparent extent of the population and small population size, potential for inadvertent trampling from recreational use, and unknown impacts of canopy closure. Ownership is private, and the owners are aware of the plant and in 1996 expressed interest in making the site part of a land trust-owned natural area.

**NH .021 (Albany)** -- This occurrence is in a beech-dominated forest on a south to southeast-facing slope (0-20 degrees). The soil is a sandy, gravelly loam with granitic boulders present. The site ranges from about 860 to 920 feet (262-280 meters) in elevation. *Fagus grandifolia* dominates, and *Betula papyrifera*, *B. alleghaniensis*, and *Quercus rubra* occur as well. *Triphora trianthophora* grows primarily in hollows filled with thick beech leaf litter; the species tends to occur with few other species, and the only associated herbaceous species growing nearby are *Epifagus virginiana* and *Monotropa uniflora*, and beech seedlings are common. The occurrence was first documented in 1995, when about 60-70 stems were located in an approximately 10 acre area (4.05 hectares); dozens more were likely present. The orchid was seen again in 1998. In 2000, 425 stems were found in approximately two acres (.81 hectares); over half of these were in an area that was logged recently. The remaining plants were located in a 200 foot diameter area (61 meters) that was set aside as a control area and was not logged. Threats to the orchid include impacts resulting from the logging (changes in soil moisture, temperature, and light regimes, mycorrhizal associations, and increased density of understory resulting in competition for the orchid). The site is publicly owned (White Mountain National Forest), and monitoring of the logged and control sites is occurring. Some plants occur on adjacent, privately owned land as well.

### Status of Vermont occurrences

Vermont has four current occurrences, three of which have been seen since 1981. One population had 35 stems in 2000 and has fluctuated from year to year; the site is publicly (Town of Brattleboro) and privately owned. Two small populations (fewer than 15 plants) were documented in 1981. At one of these sites (Vermont .001 [Dummerston], no plants were found in 1991, 1995, 1998, and 2000. At the other site (Vermont .003 [Brookline], no plants were seen in 1995 and 1998, and the site was developed. However, the population was rediscovered in 2001. In addition, a new population was discovered in Dummerston in 2001. There are three historic occurrences reported; ownership information is unknown for these sites. An additional historic occurrence (quite abundant in a small woodlot) reported in 1899 from Putney (Blanchard 1902) is not in the Vermont Natural Heritage Program data base.

**VT .001 (Dummerston)** -- This occurrence is in a mesic beech and hemlock forest. Bedrock is granitic. The site is fairly level, and light conditions are filtered to shaded in areas not recently logged; open light conditions

exist in logged areas. Elevation is approximately 1000 feet (305 meters). *Tsuga canadensis* and *Quercus rubra* now dominate. The occurrence was first documented in 1981, when 11 plants were located. The site and surrounding area was searched again in 1991, 1995, 1998, and 2000; no plants were found on any of these occasions. Directions to the original site are general, but the most likely area now has been logged and a tennis court is nearby. There is little suitable habitat (i.e., beech-dominated forest, areas with deep accumulations of beech leaf litter, mesic moisture conditions, filtered light conditions, and few or no co-occurring herbaceous and shrub species) for *Triphora trianthophora* currently. The Nature Conservancy and a local land trust or conservation group now own the site. Adjacent land (privately owned by conservation-minded individuals who are interested in the orchid) was searched on at least two recent occasions and has some potential habitat, but no plants were found at times when plants were found at a nearby site. The original population was small when first discovered and may be extirpated now.

**VT .002 (Brattleboro)** -- This occurrence is near a roadside ditch below a hemlock-dominated hillside forest. Moisture conditions are mesic, and light conditions are filtered to shaded. Elevation is approximately 800 feet (244 meters). *Tsuga canadensis* dominates at the site, and there are a few scattered individuals of *Fagus grandifolia* and *Acer saccharum*. *Triphora trianthophora* grows primarily in hollows filled with thick beech leaf litter; the species tends to occur with few other species, and the only associated herbaceous species growing nearby is *Epipactis helleborine*. *Circaea* sp., *Impatiens* sp., and *Lactuca muralis* also occur nearby in the culvert. *Triphora trianthophora* is most dense in areas with the thickest leaf litter; areas that are somewhat eroded and have little litter contain no stems. The occurrence was first documented in 1981 when 17 plants were found; in 1982, 23 plants were found. In 1995, no plants were found. In 1998, 28 stems were found, but in 1999, no stems were found in the same location. In 2000, the site was checked on three dates during the flowering season, and the maximum number of stems located on one date was 34. In addition, one stem was found on the hillside a short distance from the original population in a shallow hollow with beech and oak leaf litter near an oak, two beech, a beech snag, and a hemlock. *Epifagus virginiana*, *Monotropa* spp., and *Corallorhiza maculata* occur on the hillside, but not near the single stem. In general, the steep slope does not have good leaf litter accumulation, with the exception of a few pockets, and there are few beech in the canopy or understory. Threats to the roadside population include: potential for flooding; roadside maintenance (including culvert work; brush cutting; and road sanding); stochastic events that could eliminate the small population, unknown impacts from herbivory; and largely unsuitable habitat. The roadside population is owned publicly by the Brattleboro Department of Public Works and the hillside is owned privately.

**VT .003 (Brookline)** -- This occurrence was first documented in 1981 when 13 plants were observed. Searches in 1995 and 1998 revealed no plants, but the searches were likely conducted at a slightly different location. In 2001, 13 stems were observed in a small woodlot scattered over approximately 1/2 acre. Stems were found in shallow depressions filled with leaf litter, especially in the vicinity of boulders. Tree species listed in 1981 (*Tsuga canadensis*, *Fagus grandifolia*, and *Acer rubrum*) remain dominant in 2001. Moisture conditions are mesic, light is filtered, aspect is south-southwest on a gentle slope (< 10%). Elevation is approximately 330 feet (100 meters). No associated herbaceous plants occur in the immediate vicinity of the orchid, but *Dennstaedtia punctilobula*, *Monotropa uniflora*, *Mitchella repens*, *Uvularia sessilifolia*, and *Arisaema triphyllum* grow nearby, as well as young beech saplings. Threats include small size of the population and habitat, unknown impacts of possible changes in canopy and habitat quality, and unknown future land uses.

**VT .004 (Fair Haven)** -- This occurrence was seen and documented only in 1842. The occurrence is considered historic.

**VT .005 (Newfane)** -- This site was initially documented in 1897 in hollows of cradle knolls in beech woods; a few plants were present. It was last seen in 1898. The occurrence is considered historic.

**VT .007 (Westminster)** -- This occurrence was seen and documented only in 1899 (one plant on a rotten stump). The occurrence is considered historic.

**VT New EO (Dummerston)** -- This occurrence was first documented in 2001, and in terms of population vigor, habitat quality, and present level of protection, it is the state's best quality occurrence. The site is a largely deciduous forest with *Fagus grandifolia*, *Betula lenta*, *Quercus rubra*, *Acer rubrum*, *Tsuga canadensis*, and *Betula papyrifera* present. Plants occur on a south-southwest facing, 10-20% slope with dry-mesic moisture conditions. Elevation is approximately 425 feet (129 meters). Light is filtered. The substrate is granitic with numerous, large granitic boulders present. Few herbaceous plants grow in the immediate vicinity of the orchid (although several patches of orchid stems are growing up through ferns); nearby associated species include *Dennstaedtia punctilobula*, *Epifagus virginiana*, *Monotropa uniflora*, and beech and white pine seedlings. The orchids generally grow in shallow depressions filled with leaf litter and are especially found near boulders. One stem was found growing on a trail. Threats include possible competition from *D. punctilobula*, potential canopy and understory changes, and inadvertent trampling and disturbance from hikers and from surveying activities.

### ***Status of Massachusetts occurrences***

Massachusetts has three current occurrences, but one of these consisted of two plants and was last documented in 1981. The site is privately owned. A second current occurrence consisted of approximately 700-800 stems in 2000. The population has been well-studied over a number of years and has exhibited significant fluctuations, but the number of stems has consistently been in the hundreds. The site is owned privately by a corporation. The third current occurrence was discovered in 2000 and consists of about 35 stems (with more likely in suitable habitat not yet searched); the site is privately owned. There are two historic occurrences documented; ownership of the historic sites is unknown.

**MA .001 (Greenfield)** -- This occurrence is in a mesic beech and hemlock woods on an east facing midslope (0-20 degrees). Light conditions are shaded, and the soil is likely acidic. Elevation is about 300 feet (91 meters). Canopy species include *Fagus grandifolia*, *Tsuga canadensis*, *Acer saccharum*, and *Ostrya virginiana*. Associated species include *Epifagus virginiana*, *Maianthemum canadense*, *Monotropa uniflora*, and *Vitis* sp. The occurrence was seen and documented in 1981 only. At that time, only two plants were found in a leaf-lined depression. In 1981, threats included: stochastic events that could eliminate the small population; potential development; and timber harvest. An undocumented visit after 1981 by a person familiar with the taxon revealed no plants at the site. The occurrence may be extirpated.

**MA .003 (Deerfield)** -- This occurrence was seen and documented only in 1913. The occurrence is considered historic.

**MA .004 (Rowe)** -- This occurrence is in a relatively rich mesic forest on a steep south facing midslope (20-75 degrees). Light conditions are shaded. Elevation ranges from 820 to 900 feet (250-274 meters). Dominant tree species include *Fagus grandifolia*, *Acer saccharum*, *A. pensylvanicum*, *Fraxinus americana*, *Betula lenta*, and *Tilia americana*. The orchid grows in or near small hollows lined with leaves. Associated herbaceous species include *Polystichum acrostichoides*, *Aster divaricatus*, *Arisaema triphyllum*, *Viola rotundifolia*, *Monotropa uniflora*, *Tiarella* sp., and *Epifagus virginiana*. The occurrence was first documented in 1986 with 260 plants

found. The population was monitored in detail each year from 1988-1996; a brief visit was made in 2000 also. Population numbers have fluctuated over the years, although some differences are due to the discovery of new plants: 1988 (373 plants), 1989 (100 plants), 1990 (180 plants), 1991 (365 plants), 1992 (430 plants), 1993 (433 plants), 1994 (1471 plants), 1995 (971 plants), and 1996 (1338 plants), and 2000 (700-800 plants estimated). A private corporation owns the site, and the occurrence is included in a 1992 management agreement. Threats include: unknown impacts of herbivory; possible changes as forest mature; and localized impacts of grapevine falls.

**MA .005 (Conway)** -- This occurrence was seen and documented only in 1928. The population is considered historic.

**MA .006 (Florida)** -- This occurrence, discovered in 2000, is in a mesic, beech-dominated forest on a 0-45% mid-slope. Light conditions are shaded. Elevation is about 1200 feet (366 meters). Thirty-five stems were counted in an area of about 0.25 acre (1012 square meters). Plants grow in leaf litter deposits in hollows and along logging paths. A private individual owns the site and has expressed interest in selling the land for conservation purposes. No identified threats were identified, but the population may be affected by forest recovery after a blowdown and selective logging.

### *Status of Connecticut occurrences*

Connecticut has no extant populations; the plant was last seen in the state in 1920. There are three historic occurrences documented by the Natural Heritage Program, and several other locations according to herbarium records. Little additional information exists for the historic occurrences; the habitat for two sites was described as hemlock woods and rocky woods.

**CT .001 (New Haven)** -- This occurrence was seen and documented only in 1879 in rich hemlock woods. The occurrence is considered historic.

**CT .002 (Southington)** -- This occurrence was initially documented in 1906 in rocky woods near a lake and last seen in 1920. The occurrence is considered historic.

**CT .003 (Norwich)** -- This occurrence has no documentation date associated with it. The occurrence is considered historic.

### *Current Conservation Measures in New England*

Current conservation measures that potentially protect *Triphora trianthophora* in New England include protection under state endangered species legislation, site ownership by entities that may act to protect the species, management to protect a portion of a population from the impacts of timber harvest, and regular monitoring of a number of occurrences.

### *State Endangered Species Legislation*

In Maine, *Triphora trianthophora* is listed as a threatened species and is protected under Maine Revised Statutes Annotated 5 MSRA C, 383, sub C. III, articles 1-A. In New Hampshire, *T. trianthophora* is listed as a threatened species and is protected under the 1987 State law RSA 217-A:3, III. In Vermont, *T. trianthophora* is listed as a threatened species and is protected under the 1981 Vermont Endangered Species Law 10 V.S.A.

Chapter 123. In Massachusetts, *T. trianthophora* is listed as an endangered species and is protected under the 1992 Massachusetts Endangered Species Act, MGL c. 131A and its regulations, 321 CMR 10.00. In Connecticut, *T. trianthophora* is listed as a species of special concern that is extirpated from the state, and is protected under Public Act 89-224. While *T. trianthophora* receives legal protection in these New England states, the scope of protection provided by the legislation is limited. State endangered species acts typically prohibit the direct taking of listed species but do not prohibit taking that is incidental to and not the purpose of carrying out an otherwise lawful act. For example, in Vermont the legislation does not address threats such as land use that are incompatible with the well being of the plant unless the plant itself is taken. Also, permitting processes exist that can allow for the taking of individuals of listed taxa under certain circumstances.

### ***Site Ownership***

Conservation of *Triphora trianthophora* occurrences may result from site ownership by private or public entities that act to protect the plant. There are six occurrences in Maine and New Hampshire found on White Mountain National Forest land. The Forest Service is aware of these occurrences, and endeavors to protect listed species such as *T. trianthophora*. Several occurrences are on land owned by private individuals. One is owned by corporation with interests in the conservation of the species and its habitat, and another by a town potentially willing to accommodate the species. One site in Vermont is owned by a private conservation organization. Approximately half of the current occurrences of *T. trianthophora* in New England are on privately owned land with no formal or informal conservation measures in place.

### ***Management***

One portion of an occurrence in the White Mountain National Forest was protected from a timber harvest conducted at the site. Data will be collected over several years to assess impacts of timber harvest on *Triphora trianthophora*. No other management activities are known for *T. trianthophora* in New England. Various management suggestions have included canopy thinning, preventing timber harvest, rerouting trails and woods roads, preventing development, and modifying roadside maintenance activities.

### ***Monitoring***

Although monitoring of populations is not a conservation measure in itself, it is essential for establishing the current status of populations and to assess population trends. It is also a prerequisite to implementation of management activities. In the past 20 years, approximately one-third of the current New England occurrences have been monitored for Natural Heritage Programs as many as four times, but the monitoring intervals are not consistent.

### ***Conservation Objectives for the Taxon in New England***

Four conservation objectives are proposed for *Triphora trianthophora* to ensure its persistence in New England during the next 20 years. The first objective is to maintain, at a minimum, the existing number of occurrences at their current population levels. The second objective is to search for previously undocumented occurrences and to protect newly found populations when possible. The third objective is to identify and protect promising

habitat that is apparently unoccupied by the orchid currently. The fourth objective is to evaluate the possibility of augmentation, reintroduction, and introduction of the orchid. Specifically, the result of achieving the above objectives should be the presence of 20 protected occurrences. At least half of the occurrences should have greater than 100 stems present aboveground in any given year (or another similar threshold value that is established). Although 100 stems is perhaps an arbitrary and conservative threshold for extreme concern for populations, the four current populations that may now be extirpated (ME .006, VT .001, VT .002, and MA .001) had fewer than 20 stems present at their most recent survey. It is prudent maintain populations above thresholds from which populations may not recover.

A discussion of the rationale for developing these four conservation objectives for *Triphora trianthophora* follows. First, the most effective way to ensure the long-term viability of plant species is to protect large numbers of healthy populations in natural habitat; protecting the remaining *T. trianthophora* occurrences through the first objective is essential to this effort. Second, *T. trianthophora* is represented in New England by 24 occurrences, a relatively low number. Furthermore, three of these occurrences are possibly extirpated based on recent field observations (ME .006 [Stow], VT .001 [Dummerston], and MA .001 [Greenfield]). Five additional occurrences had fewer than 50 stems found at the most recent surveys (ME .004 [Hiram], NH .001 [Madison], NH .002 [Conway], VT .002 [Brattleboro], and VT .003 [Brookline]). Only ten occurrences had greater than 100 stems present at the most recent surveys (ME .001 [Stow], ME .005 [Raymond], ME .007 [Parsonfield], NH .003 [Madison], NH .004 [Wakefield], NH .005 [Albany], NH .006 [Holderness], NH .021 [Albany], VT .008 [Dummerston], and MA .004 [Rowe]). The number of known and protected occurrences should include a minimum of 20 protected occurrences.

The second objective of searching for previously unknown populations will help to increase the number of known occurrences. Twenty occurrences would be approximately half of the combined total of 42 historic and current occurrences reported, and this figure represents the threshold number of occurrences for a NEPCoP Division 2 plant species (Brumback and Mehrhoff *et al.* 1996). Small populations of *T. trianthophora* are more susceptible to extirpation than are larger populations; as mentioned previously, several smaller current populations are probably extirpated. Thus, it is important to conserve a significant number of populations (approximately half of the occurrences) with at least 100 stems present in any given year. Long-term conservation of *T. trianthophora* in New England will likely require the persistence of a minimum of 20 occurrences and the presence of a minimum of 10 with greater than 100 stems present.

Third, although protection of apparently unoccupied habitat might be viewed as a low priority compared with the substantial protection needs of known populations, it is a high priority for this taxon because plants may actually be present in the form of underground tuberoids.

Fourth, while augmentation, introduction, or reintroduction of *T. trianthophora* are not presently recommended, it is prudent to explore the desirability and feasibility of such actions now so that information will be available to inform future decisions.

Determination of the number of populations, their size, and their distribution required for successful conservation of any taxon is clearly a subjective and dynamic endeavor. The conservation objectives and actions presented here should be viewed as initial recommendations that will be modified as a new information becomes available and is evaluated.

### ***General Conservation Actions for the Taxon***

General conservation actions for threatened and endangered plant taxa typically include the following actions: land acquisition or protection; regular surveys of known occurrences; *de novo* searches for new populations; species biology research; habitat or site management; *ex-situ* activities including seed banking; germination research and propagation; reintroduction including augmentation, introduction, and reintroduction; and education of landowners and the public. These general conservation actions are discussed below with particular reference to *Triphora trianthophora* in New England. Any preliminary work necessary to support the conservation actions and a proposed general chronology for initiating the conservation actions is presented as well.

### ***Land acquisition or protection of occurrences***

A conservation strategy focusing on protection of existing populations is likely to be the most successful strategy from a biological standpoint. Land acquisition by entities that protect *T. trianthophora* will aid substantially in conserving the taxon. Similarly, protection of occurrences by current landowners will aid in conservation. Acquisition and protection of occurrences can prevent/minimize threats such as development and incompatible timber harvest activities. Priority sites include: ME .001 [Stow]; ME .005 [Raymond]; ME .007 [Parsonfield]; NH .005 [Albany]; NH .006 [Holderness]; NH .021 [Albany]; VT .002 [Brattleboro]; MA .004 [Rowe]; and MA .006 [Florida]. These priority sites are occurrences of especially high quality in terms of population size and habitat quality, ones faced with imminent threats, and/or occurrences in states that have few current occurrences. Preliminary steps to acquisition and protection will be site specific but may include: determining land ownership; talking with landowners; and research to determine appropriate management practices. This conservation action helps to meet all four conservation objectives.

In addition to the protection of known occurrences, the protection of potential habitat is important in the conservation of *Triphora trianthophora* because apparently unoccupied habitat may actually contain tuberoids. Additionally, such habitat can accommodate changes that occur both in ecological and in evolutionary time. At many sites, suitable habitat appears to exist with no aboveground plants currently present. Such areas of apparently suitable habitat are important to protect in the event of extirpation of currently known occurrences. For example although no aboveground stems were observed over a six-year period in certain localities at one site, underground tuberoids were nonetheless present in the soil (Williams 1994). Preliminary work with regard to this action includes: identifying occurrences that are likely to have potential habitat nearby based on habitat characteristics typical for the orchid; discussing with knowledgeable persons what areas may be good candidates, both biologically and logistically, for protection; determining ownership of potential habitat both for purposes of landowner permission and likelihood of protection; determining likelihood of protection through discussions with landowners. Acquisition and protection of promising habitat apparently unoccupied by the orchid supports the second, third, and fourth objectives.

### ***Regular surveys (and inventories) of known occurrences***

An understanding of population levels and fluctuations is fundamental to conserving the taxon. Regular surveys help to develop an understanding of the orchid's natural population fluctuations (Williams 1994) and can be used to assess population responses to anthropogenic activities and natural disturbances. Additionally, without

regular monitoring, it would be impossible to assess the success or failure of any management practices implemented. However, because the plant may exist as an underground tuberoid for extended periods of time, it is impossible to assess the true population size; counts will reveal only the number of aboveground stems produced. An important preliminary step in carrying out this action is to develop a consistent and minimum-impact monitoring technique for estimating population size to be used at all sites. Consultation with researchers familiar with the species will be helpful in this regard. A proposed method is to count stems and approximate the area encompassing the plants. Although time consuming, precise mapping of the occurrences would be useful. However, if there is danger of damage to the plants and/or disruption of the habitat, an overview of populations from the edges of the occurrence may be necessary. Also, for sites with a large number of stems and/or large acreages, sampling of a subset of the plants and area may be necessary. The use of photography with benchmarks may be useful as well. More detailed demographic studies focusing on dormancy and survival have been done for other orchid species (Shefferson et al. 2001) and may be appropriate for *Triphora* as well if they can be completed without injuring individuals or habitat. In general, monitoring should occur every three years and more frequently if threats are imminent. This conservation action helps to meet the first and second conservation objectives.

### ***De novo searches for new populations***

The discovery of new populations and the subsequent protection of these occurrences will be of great benefit in increasing the number of known, protected populations. One discovery of a previously unknown population was made in 2000 in Massachusetts, and another was made in 2001 in Vermont. Searches should take place near known occurrences and in other likely habitat. Although orchids are well-studied in general, *T. trianthophora's* cryptic nature makes it elusive, and it may have been overlooked. Several occurrences of *T. trianthophora* have been found relatively recently in Maine (Eastman 1969; Eastman 1972), Louisiana (Holmes 1980), Virginia (Ogle 1975), and South Carolina (Porcher 1977). Preliminary steps in searching for new populations include: identifying likely potential areas based on investigation of areas near current and historic occurrences and talking with persons familiar with taxon who may know of other likely areas to search. Techniques such as computerized habitat modeling may lead to the discovery of new populations as it did for another rare orchid in the northeast (Sperduto 1995). This conservation action helps to meet the second conservation objective.

### ***Species biology research***

An understanding of certain elements of the taxon's biology is important in conservation efforts. Specifically, determining optimal and acceptable light, moisture, and leaf litter and soil conditions will allow for appropriate management decisions to be made. Paired comparisons of beech-dominated sites that do and do not support *Triphora trianthophora* may be informative. Although impacts from timber harvest are generally viewed as negative for forest herbs, comments in Natural Heritage Program data bases suggest that canopy thinning may be appropriate in conditions that are thought to be too shaded. Additionally, there are several comments in the data bases suggesting that opening up the canopy through timber harvest may benefit the species and its habitat. Precise light requirements for the orchid are unknown. However, many of the best sites occur in mature beech forests. Many other aspects of the biology of *T. trianthophora* are of interest and potentially important in management of the species; these include: mycorrhizal and saprophytic relationships; pollination; seedling establishment; vegetative reproduction; genetic diversity; and impacts of herbivory. However, research in these areas is not likely to be crucial to management decisions and/or the research may prove too difficult to conduct

in a non-destructive fashion. Because mycorrhizal associations are likely to be crucial to the existence of the orchid, they should be considered for study; studies on other orchids may provide insights as to the importance of additional information for management and the costs to populations of conducting such research (Taylor and Bruns 1997 and Kristiansen 2000). Woody debris is also known to be important for seed germination in certain orchid species (Rasmussen and Whigham 1998). This conservation action helps to meet all four conservation objectives.

### ***Habitat or site management***

As mentioned above, the precise requirements of the species are unknown, but likely management includes: developing timber harvest plans that are compatible with the conservation of the species or restricting timber harvest in certain circumstances; canopy thinning to favor beech; promoting soil and leaf litter conditions conducive to healthy populations; actions such as rerouting trails and woods roads; undertaking compatible roadside management activities; and planning development appropriately. A thorough, nation-wide investigation of management practices that have been employed in the conservation of *T. trianthophora* as well as discussions with knowledgeable persons in New England are necessary. Of particular interest are efforts related to providing an ideal light, moisture, and litter environment (such as canopy thinning and appropriate timber management plans). Proposals for habitat and site management will be dependent on adequate knowledge of the taxon's biology. This conservation action helps to meet all four conservation objectives.

### ***Ex-situ activities including seed banking, germination research, and propagation***

These activities would be essential if any future reintroduction efforts were to take place. However, the desirability and feasibility of reintroduction and *ex-situ* activities for the taxon are unclear. Typically, orchids are difficult to propagate via seed or vegetative parts. Additionally, *T. trianthophora* produces capsules infrequently. Blanchard (1902) states that artificial propagation of bulbs (tuberoids) might be successful. Correll (1950) notes that the orchid was introduced into England around 1824 and that the plants subsequently flowered. It is possible (but not necessarily advisable) that tubers could be transplanted successfully (Sue Williams, consulting botanist, personal communication). Luer (1975) eloquently cautions against any attempts, likely to be unsuccessful in the long-term, to transplant native orchid species. *Ex-situ* activities help to meet the fourth conservation objective; any *ex-situ* activities should be engaged in conservatively as suggested below.

### ***Augmentation, introduction, and reintroduction***

As a theoretical conservation measure, it could be beneficial re-introduce the orchid into some areas of its historical occurrence, introduce it to suitable, nearby habitat, and augment small populations. Despite the theoretical benefit of such restoration efforts, there are potential detrimental effects and substantial obstacles associated with restoration efforts. These include altering the genetic makeup of populations, disruption of habitat, the potential for introduction of disease, the intensive management required for such efforts, and the general lack of success in transplanting or seeding orchids. As mentioned above, reintroduction hinges on successful *ex-situ* activities, and these are dubious for the taxon. Questions regarding the desirability and feasibility of reintroduction must be addressed before embarking on reintroduction efforts.

Because of the substantial concerns regarding augmentation, introduction, and re-introduction, these actions are not recommended at the present time. However, a group of experts should explore issues related to the actions, and background information should be gathered in the event that the actions become necessary in the future.

Investigation of augmentation, introduction, and reintroduction should include: determining if augmentation, introduction, and reintroduction are desirable through discussions among experts on the taxon, state Natural Heritage Programs, NEWFS, and landowners; determining if there is a source of tuberoids that will not compromise the well-being of existing natural populations (if a portion of a population were going to be destroyed unavoidably, this would be a possible source of tuberoids that could be used in transplantation); determining if transplantation of tuberoids is possible by investigating if any successful transplantations have occurred and what methods have been used; determining areas likely for reintroduction if the above concerns are answered in the affirmative; looking in and around historic sites and likely habitat in their towns of occurrence for appropriate sites; determining if there are likely occurrences as sites for augmentation by identifying occurrences that have potential unoccupied habitat nearby; determining if artificial pollination enhances seed production and establishment of individuals. This conservation action helps to meet the fourth conservation objective.

If it is determined that augmentation, introduction and/or reintroduction are desirable and if *ex-situ* propagation is successful, then these restoration efforts may help to ensure the conservation of the taxon. This would be important in Connecticut where the taxon has likely been extirpated and in states where there are few known extant populations: Vermont (one occurrence) and Massachusetts (three occurrences). Augmentation could expand the spatial coverage of the orchid at appropriate sites and reduce the risk of extirpation of the orchid through random events. In many cases, the plant is restricted to a small area and is represented by few individuals, and there is potentially suitable habitat nearby. If augmentation were to occur in the future, the focus should be on smaller populations with fewer than 50 aboveground stems present. If this action were taken, augmentation should occur at a single locality until the results and consequences are known.

### ***Education of landowners and the public***

Knowledge of the taxon and its conservation needs on the part of landowners and the public is essential in developing a successful conservation strategy. Information about the taxon can help to guide activities such as development, timber harvest, recreation, and road maintenance. Education that helps to ensure the persistence of the species should be available to landowners, individuals who use lands on which the taxon occurs, researchers, botanists (amateur and professional), and those carrying out activities that may affect the taxon. The benefits of educational efforts must be balanced carefully with the benefits of maintaining the confidentiality of details of the populations. This conservation action helps to meet all four conservation objectives.

A general chronology for meeting the conservation needs of *Triphora trianthophora* in New England can be based primarily on prioritization of the stated conservation objectives. As discussed in this section, there are a number of instances in which preliminary work needs to be completed before the conservation actions supporting the conservative objectives can be carried out.

The first objective, to maintain the existing number of occurrences at current population levels, is the most important objective in conserving *T. trianthophora* and should receive immediate attention. The conservation actions that support this objective are: land acquisition and protection of occurrences; education; regular surveys; management; and species biology research.

The second objective, to search for previously undocumented occurrences and to provide protection for newly discovered populations, is the second most important objective. Conservation actions that support this second objective include *de novo* searches for new populations and the actions listed above for the first objective.

The third objective, to identify and protect promising habitat that is apparently unoccupied by the orchid, is the next most important objective. While this third objective is important in a long-term conservation strategy for *T. trianthophora*, the objective will be difficult to achieve and is likely less important than the first two objectives in conserving the orchid. Conservation actions required to meet this objective initially include: education; land acquisition; and species biology research.

The final objective, to evaluate the possibility of augmentation, introduction, and reintroduction, is the lowest priority objective. Conservation actions required to meet this objective include the preliminary work discussed previously and *ex-situ* activities.

This general chronology should be viewed as a basic framework for the order or priority for carrying out the conservation objectives and actions. However, it is likely that implementation will reveal complexities in the order in which work should be completed. Many of the conservation actions are interdependent and difficult to carry out in isolation of one another. For example, protection of occurrences may be dependent on management, which is ultimately dependent on species biology research. It would be difficult to suggest a general chronology for carrying out these actions that could be applied to all occurrences.

### ***Recommended Conservation Actions for Each Occurrence***

The following section describes recommended conservation actions for each *Triphora trianthophora* occurrence in New England. The actions are designed to meet the conservation objectives discussed previously. The implementation of these actions will require conservation funds and personnel beyond those available currently for threatened and endangered plants in New England. As the phrase suggests, these recommended conservation actions should be viewed as recommendations and should be modified to best ensure the conservation of *T. trianthophora* in New England.

#### **Maine**

**ME .001 (Stow)** -- Develop a site management plan with WMNF (especially with regard to timber harvest, trail location, and canopy closure). Monitor population and habitat every three years. Identify and protect suitable habitat that is apparently unoccupied. Determine education strategy for forest users. Include site in study of relationship between orchid viability and light, moisture, and leaf litter conditions.

**ME .002 (Stow)** -- Revisit to determine if still extant; if extant, monitor and develop a site management plan with WMNF.

**ME .003 (Stoneham)** -- Develop a site management plan with WMNF. Monitor population and habitat every three years (especially to determine course of recovery after severe ice storm damage). Determine extent of population. Identify and protect suitable habitat that is apparently currently unoccupied. Determine if taxon is on private land as well as Forest Service land.

**ME .004 (Hiram)** -- Revisit to determine current status of population. Discuss possible conservation measures with landowners; they have expressed an interest in conserving the orchid. Monitor population and habitat every three years.

**ME .005 (Raymond)** -- Determine all landowners and discuss conservation measures with landowners (especially impacts of path, campfire wood collection, and potential development). Monitor population and habitat every two years. Determine education strategy for landowners and land users. Include site in study of relationship between orchid viability and light, moisture, and leaf litter conditions.

**ME .006 (Stow)** -- Determine if population is still extant; pursue protection if it is extant.

**ME .007 (Parsonfield)** -- Monitor population and habitat every three years (especially plants' response to succession after heavy cutting in the 1980s). Landowners will likely carry out yearly monitoring; they are knowledgeable and concerned about well being of the orchid. Map extent of occurrence. Identify and protect suitable habitat that is apparently currently unoccupied. Discuss management strategies with landowners. Include site in study of relationship between orchid viability and light, moisture, and leaf litter conditions.

## **New Hampshire**

**NH .001 (Madison)** -- Determine ownership. Develop management plan with owners. Monitor population and habitat every three years (especially with regard to ice storm damage and timber harvest).

**NH .002 (Conway)** -- Determine ownership. Revisit to determine if population is still extant; if extant, monitor and develop site management plan with owners.

**NH .003 (Madison)** -- Determine ownership. Discuss protection options with owners. Monitor population and habitat every three years. Identify and protect suitable habitat that is apparently currently unoccupied by plants. Include site in study of relationship between orchid viability and light, moisture, and leaf litter conditions.

**NH .004 (Wakefield)** -- Discuss protection options with landowners. Monitor population and habitat every three years. Identify and protect suitable habitat that is apparently currently unoccupied by plants. Include site in study of relationship between orchid viability and light, moisture, and leaf litter conditions.

**NH .005 (Albany)** -- This is an excellent population in natural habitat, but the area could be developed or harvested for timber; protection is a high priority. Work with landowners to achieve protection. Acquisition of land or an easement would be ideal; the site is adjacent to White Mountain National Forest Land. Monitor population and habitat every three years. Identify and protect suitable habitat that is apparently currently unoccupied. Include site in study of relationship between orchid viability and light, moisture, and leaf litter conditions.

**NH .006 (Holderness)** -- Landowner is aware of population and interested in its conservation; encourage protection by landowner (especially with regard to future potential timber harvest and development plans). Work with town to reduce impacts of roadside maintenance. Monitor population and habitat every three years. Determine extent of population. Contact individual (Philip Keenan) who has monitored and studied the population for years for ideas on conservation and management. Include site in study of relationship between orchid viability and light, moisture, and leaf litter conditions.

**NH .007 (Tamworth), NH .008 (Laconia), NH .009 (Meredith), and NH .010 (Tamworth)** -- These are considered historic populations. A few of these occurrences and likely habitat nearby should be explored to see if any of these occurrences are still extant. Reintroduction into some of these areas should be evaluated.

**NH .011 (Chatham)** -- Revisit to determine if population is still extant; if extant, monitor and develop a site management plan with WMNF.

**NH .012 (Holderness), NH .013 (Winchester), and NH .014 (Hillsborough)** -- These are considered historic populations. A few of these occurrences and likely habitat nearby should be explored to see if any of these occurrences are still extant. Reintroduction into some of these areas should be evaluated.

**NH .015 (Chatham)** -- Revisit to collect more information on the ecology of the population and its status; original visit focused on forests in the area and not on the plant. Develop a site management plan with WMNF. Monitor population and habitat every three years.

**NH .016 (Conway), NH .017 (Hillsborough), NH .018 (Bartlett), and NH .019 (Holderness)** -- These are considered historic populations. A few of these occurrences and likely habitat nearby should be explored to see if any of these occurrences are still extant. Reintroduction into some of these areas should be evaluated.

**NH .020 (Sandwich)** -- Discuss protection measures with landowners; owners are cooperative and expressed an interest in a conservation easement in 1996. Revisit to determine population size. Monitor every three years. Explore possible management (canopy thinning).

**NH .021 (Albany)** -- This is an excellent potential population and protection is a priority. Many plants were found in an area of a heavy selective cut. Part of the area was set aside and left uncut to protect plants, but many plants were found in the cutover area. Determine current monitoring procedures. Determine extent of population. Determine ownership of adjacent land containing plants. Develop a site management plan with WMNF and adjacent landowner if appropriate. Restrict further cutting. Monitor yearly to assess impacts of heavy cutting. Include site in study of relationship between orchid viability and light, moisture, and leaf litter conditions.

## **Vermont**

**VT .001 (Dummerston)** -- This area has been searched to no avail four times in the last nine years. There is potential habitat (although not ideal habitat), so it is worth another try. Search again while nearby VT .002 is in bloom. Identify potential habitat that is of high quality for the possibility of protection.

**VT .002 (Brattleboro)** -- This is one of three Vermont occurrences seen since the early 1980s, and is a high priority for protection. Contact town and ensure that population will not be impacted as a result of road maintenance. Monitor yearly. One stem was found on hillside; landowner should be contacted to explore

protection possibilities and another search should be carried out to see if more can be found. Identify and protect suitable habitat that is apparently currently unoccupied. Possible management to reduce soil slippage and to encourage development of deep leaf litter; selective cutting to encourage beech. These management activities should take place only after obtaining information suggesting that such management is likely to be beneficial and unlikely to be detrimental. Include site in study of relationship between orchid viability and light, moisture, and leaf litter conditions.

**VT .003 (Brookline)** -- This is a small site that has good quality habitat. Only 13 stems were found in 2001 in the area searched, but it was a dry year and more stems may emerge in more favorable years. There may be additional habitat nearby in addition to the approximately 1/2 acre searched. Discuss protection options with landowner. Re-survey to attempt to find additional stems and habitat; monitor every three years. Include site in study of relationship between light, moisture, and leaf litter conditions and orchid viability.

**VT .004 (Fair Haven), VT .005 (Newfane), and VT .007 (Westminster)** -- These are considered historic populations and are likely extirpated. Because there is only a single (very threatened) extant population in Vermont, some select suitable habitat in the three towns should be investigated for the possibility of extant populations and evaluated for the possibility of reintroduction.

**VT New EO (Dummerston)** -- This site was first documented in 2001. In terms of population vigor, habitat quality, and level of protection, it is the best occurrence known in Vermont. The site should be a high priority for protection. Recommended conservation actions include: evaluating the possibility of removing competing understory vegetation in some areas; considering trail relocation (contact landowner/manager to discuss both of these); determining extent of likely habitat on the parcel where the orchid is located and on adjacent privately owned land; re-surveying to determine if additional stems can be found; monitoring every three years; including the site in a study of the relationship between orchid viability and light, moisture, and leaf litter conditions.

## **Massachusetts**

**MA .001 (Greenfield)** -- Permission to visit the site in 2000 was denied by the landowner. Attempt again to get permission to revisit site and surrounding area to determine if population is still extant. If extant, discuss possible conservation measures with landowner and monitor.

**MA .003 (Deerfield) and MA .005 (Conway)** -- These are considered historic occurrences. Suitable habitat should be searched to see if any populations can be re-located. Evaluate possibility of reintroduction.

**MA .004 (Rowe)** -- This is one of the best populations in New England and should be protected by whatever means possible. Develop a long-term management plan with corporate landowner (has been cooperative and no imminent threats; a 1992 cooperative management agreement exists). Monitor every three years. Include site in study of relationship between orchid viability and light, moisture, and leaf litter conditions.

**MA .006 (Florida)** -- This is a newly discovered population with substantial potential habitat nearby. Revisit to determine extent and size of population in 2001. Pursue protection measures with landowners. Monitor every three years.

## **Connecticut**

**CT .001 (New Haven), CT .002 (Hartford), and CT .003 (New London)** -- These are considered historic populations. Some select suitable habitat in the three towns should be investigated for the possibility of extant populations and evaluated for the possibility of re-introduction

### **Prioritized implementation table**

The prioritized implementation table that follows (Table 3) lists and ranks actions that should be undertaken in order to implement the conservation plan for *Triphora trianthophora*. The schedule is subject to revision based on annual review of conservation objectives. Conservation actions are arranged in priority order based on the following definitions:

Priority 1 – An action that should be taken to prevent irreversible declines in the species’ status in New England.

Priority 2 – An action that should be taken to prevent or reverse significant declines in the species’ status in New England.

Priority 3 and 4 – All other actions necessary to meet the conservation objectives.

As landowner contact is required for each site to gain site access and permission to perform other research activities, it is considered a priority action and will not be listed separately for each occurrence unless special circumstances exist. Conservation activities to follow assume landowner permission has been acquired.

**Table 3. Prioritized Implementation Table for Conservation Actions for *Triphora trianthophora*.  
Landowner permission is pre-requisite to these actions.**

State	E.O.	Town	First Priority	Second Priority	Third Priority	Fourth Priority
ME	.001	Stow	Develop a site management plan with WMNF (especially with regard to timber harvest, trail location, and canopy closure)	Monitor population and habitat every three years; identify apparently unoccupied habitat nearby for protection	Determine education strategy; include site in study of relationship between light, moisture, and leaf litter conditions and orchid viability	
ME	.002	Stow		Revisit site to determine if population is still extant; if extant, monitor and develop a site management plan with WMNF		
ME	.003	Stoneham	Develop a site management plan with WMNF; determine if plants are on private land also	Monitor population and habitat every three years; determine extent of population; identify apparently unoccupied habitat nearby for protection		
ME	.004	Hiram		Revisit to determine current status of population; discuss possible conservation measures with landowners; monitor population every three years		
ME	.005	Raymond	Determine all landowners and discuss conservation measures (especially impacts of path, campfire wood collection, and development)	Monitor population and habitat every two years; determine education strategy for landowners and land users	Include site in study of relationship between light, moisture, and leaf litter conditions and orchid viability	
ME	.006	Stow		Determine if population is still extant; pursue protection if extant		
ME	.007	Parsonfield		Site currently secure; monitor population and habitat ever three years; map extent of occurrence; identify apparently unoccupied habitat nearby for protection	Discuss management strategies with landowners; include site in study of relationship between light, moisture, and leaf litter conditions and orchid viability; map extent of occurrence	
Future ME Sites			Search for previously unknown occurrences		See information for historic occurrences	

**Table 3. Prioritized Implementation Table for Conservation Actions for *Triphora trianthophora*.  
Landowner permission is pre-requisite to these actions.**

State	E.O. #	Town	First Priority	Second Priority	Third Priority	Fourth Priority
NH	.001	Madison	Determine ownership; develop management plan with owners	Monitor population and habitat every three years (especially with regard to changes after ice storm and timber harvest)		
NH	.002	Conway	Determine ownership	Revisit to determine if population is still extant; if extant monitor and develop site management plan with owners		
NH	.003	Madison	Determine landowners; discuss protection with landowners	Monitor population and habitat every three years; identify apparently unoccupied habitat nearby for protection	Include site in study of relationship between light, moisture, and leaf litter conditions and orchid viability	Possible management to reduce competition from herbaceous species
NH	.004	Wakefield	Discuss protection with landowners	Monitor population and habitat every three years; identify apparently unoccupied habitat nearby for protection	Include site in study of relationship between light, moisture, and leaf litter conditions and orchid viability	
NH	.005	Albany	Protection of this excellent quality EO and habitat is a high priority: work with landowners to achieve protection through acquisition or easement	Monitor population and habitat every three years; identify apparently unoccupied habitat nearby for protection	Include site in study of relationship between light, moisture, and leaf litter conditions and orchid viability	
NH	.006	Holderness	Discuss protection measures with landowner (especially with regard to future potential timber harvest and development plans); contact town about protection of roadside plants	Monitor population and habitat every three years; determine extent of population	Discuss site with Philip Keenan who has monitored population for years; include site in study of relationship between light, moisture, and leaf litter conditions and orchid viability	
NH	.007	Tamworth		Attempt to relocate population	Determine if reintroduction is desirable and feasible	
NH	.008	Laconia		Attempt to relocate population	Determine if reintroduction is desirable and feasible	
NH	.009	Meredith		Attempt to relocate population	Determine if reintroduction is desirable and feasible	

**Table 3. Prioritized Implementation Table for Conservation Actions for *Triphora trianthophora*.  
Landowner permission is pre-requisite to these actions.**

State	E.O.	Town	First Priority	Second Priority	Third Priority	Fourth Priority
NH	.010	Tamworth		Attempt to relocate population	Determine if reintroduction is desirable and feasible	
NH	.011	Chatham		Revisit to determine if population is still extant; if extant, monitor and develop a site management plan with WMNF		
NH	.012	Holderness		Attempt to relocate population	Determine if reintroduction is desirable and feasible	
NH	.013	Winchester		Attempt to relocate population	Determine if reintroduction is desirable and feasible	
NH	.014	Milford		Attempt to relocate population	Determine if reintroduction is desirable and feasible	
NH	.015	Chatham	Revisit and determine population size; develop a site management plan with WMNF	Monitor population and habitat every three years		
NH	.016	Conway		Attempt to relocate population	Determine if reintroduction is desirable and feasible	
NH	.017	Hillsborough		Attempt to relocate population	Determine if reintroduction is desirable and feasible	
NH	.018	Bartlett		Attempt to relocate population	Determine if reintroduction is desirable and feasible	
NH	.019	Holderness		Attempt to relocate population	Determine if reintroduction is desirable and feasible	
NH	.020	Sandwich	Protect population -- owners have expressed interest in protection for the orchid through an easement	Determine population size; monitor population and habitat every three years	Possible management--canopy thinning	
NH	.021	Albany	Protection of this large population is a priority--determine current monitoring procedures; determine extent of population; determine ownership of adjacent land containing plants; develop a site management plan with WMNF	Monitor every year to assess impacts of heavy cutting; identify apparently unoccupied habitat nearby for protection	Include site in study of relationship between light, moisture, and leaf litter conditions and orchid viability--this should be done especially with regard to response to heavy cutting	

**Table 3. Prioritized Implementation Table for Conservation Actions for *Triphora trianthophora*.  
Landowner permission is pre-requisite to these actions.**

State	E.O. #	Town	First Priority	Second Priority	Third Priority	Fourth Priority
			and adjacent landowner if appropriate			
Future NH Sites			Search for previously unknown occurrences		See information on historic occurrences	
VT	.001	Dummerston	Revisit general area to attempt to find plants	Identify apparently unoccupied habitat nearby for protection		
VT	.002	Brattleboro	This is the only known VT occurrence and is a high priority for protection: contact town and ensure that population is protected; contact owner of hillside to discuss protection; monitor each year	Identify apparently unoccupied habitat nearby for protection; determine if management would be beneficial: (reduce soil slippage, encourage development of deep leaf litter, selective cut to encourage beech)	Include site in study of relationship between light, moisture, and leaf litter conditions and orchid viability	
VT	.003	Brookline	Discuss protection possibilities with landowner	Re-survey to attempt to locate additional habitat and stems; monitor population every three years	Include site in study of relationship between light, moisture, and leaf litter conditions and orchid viability	
VT	.004	Fair Haven		Attempt to relocate population	Determine if reintroduction is desirable and feasible	
VT	.005	Newfane		Attempt to relocate population	Determine if reintroduction is desirable and feasible	
VT	.007	Westminster		Attempt to relocate population	Determine if reintroduction is desirable and feasible	
VT	New	Dummerston	Discuss management (removal of competing understory vegetation and trail relocation) with landowner/manager	Determine extent of likely habitat on parcel where orchid is located and on adjacent privately owned land; re-survey to look for additional stems.	Include site in study of relationship between light, moisture, and leaf litter conditions and orchid viability	
Future VT Sites			Search for previously unknown occurrences		See information on historic occurrences	
MA	.001	Greenfield	Attempt to get permission to revisit site and surrounding area to search for plants; if extant,			

**Table 3. Prioritized Implementation Table for Conservation Actions for *Triphora trianthophora*.  
Landowner permission is pre-requisite to these actions.**

State	E.O. #	Town	First Priority	Second Priority	Third Priority	Fourth Priority
			discuss possible conservation measures with landowner and monitor			
MA	.003	Deerfield		Attempt to relocate population	Determine if reintroduction is desirable and feasible	
MA	.004	Rowe	This is one of New England's highest quality occurrences and should continue to be protected; develop a long term management plan with owner (a 1992 management agreement exists)	Monitor every three years	Include site in study of relationship between orchid viability and light, moisture, and leaf litter characteristics	
MA	.005	Conway		Attempt to relocate population	Determine if reintroduction is desirable and feasible	
MA	.006	Florida	Revisit to determine extent and size of population; pursue protection measures	Monitor every three years		
Future MA Sites			Search for previously unknown occurrences		See information on historic occurrences	
CT	.001	New Haven		Attempt to relocate population	Determine if reintroduction is desirable and feasible	
CT	.002	Southington		Attempt to relocate population	Determine if reintroduction is desirable and feasible	
CT	.003	Norwich		Attempt to relocate population	Determine if reintroduction is desirable and feasible	
Future CT sites			Search for previously unknown occurrences		See information on historic occurrences	

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## **APPENDICES**

### **Appendix 1.**

#### **Personal communication references**

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## **Appendix 2. An explanation of conservation ranks used by The Nature Conservancy and the Association for Biodiversity Information**

The conservation rank of an element known or assumed to exist within a jurisdiction is designated by a whole number from 1 to 5, preceded by a G (Global), N (National), or S (Subnational) as appropriate. The numbers have the following meaning:

- 1 = critically imperiled
- 2 = imperiled
- 3 = vulnerable to extirpation or extinction
- 4 = apparently secure
- 5 = demonstrably widespread, abundant, and secure.

G1, for example, indicates critical imperilment on a range-wide basis—that is, a great risk of extinction. S1 indicates critical imperilment within a particular state, province, or other subnational jurisdiction—i.e., a great risk of extirpation of the element from that subnation, regardless of its status elsewhere. Species known in an area only from historical records are ranked as either H (possibly extirpated/possibly extinct) or X (presumed extirpated/presumed extinct). Certain other codes, rank variants, and qualifiers are also allowed in order to add information about the element or indicate uncertainty.

Elements that are imperiled or vulnerable everywhere they occur will have a global rank of G1, G2, or G3 and equally high or higher national and subnational ranks. (The lower the number, the "higher" the rank, and therefore the conservation priority.) On the other hand, it is possible for an element to be rarer or more vulnerable in a given nation or subnation than it is range-wide. In that case, it might be ranked N1, N2, or N3, or S1, S2, or S3 even though its global rank is G4 or G5. The three levels of the ranking system give a more complete picture of the conservation status of a species or community than either a range-wide or local rank by itself. They also make it easier to set appropriate conservation priorities in different places and at different geographic levels. In an effort to balance global and local conservation concerns, global as well as national and subnational (provincial or state) ranks are used to select the elements that should receive priority for research and conservation in a jurisdiction.

Use of standard ranking criteria and definitions makes Natural Heritage ranks comparable across element groups—thus G1 has the same basic meaning whether applied to a salamander, a moss, or a forest community. Standardization also makes ranks comparable across jurisdictions, which in turn allows scientists to use the national and subnational ranks assigned by local data centers to determine and refine or reaffirm global ranks.

Ranking is a qualitative process: it takes into account several factors, including total number, range, and condition of element occurrences, population size, range extent and area of occupancy, short- and long-term trends in the foregoing factors, threats, environmental specificity, and fragility. These factors function as guidelines rather than arithmetic rules, and the relative weight given to the factors may differ among taxa. In some states, the taxon may receive a rank of SR (where the element is reported but has not yet been reviewed locally) or SRF (where a false, erroneous report exists and persists in the literature). A rank of S? denotes an uncertain or inexact numeric rank for the taxon at the state level.

Within states, individual occurrences of a taxon are sometimes assigned element occurrence ranks. Element occurrence (EO) ranks, which are an average of four separate evaluations of quality (size and productivity), condition, viability, and defensibility, are included in site descriptions to provide a general indication of site

quality. Ranks range from: A (excellent) to D (poor); a rank of E is provided for element occurrences that are extant, but for which information is inadequate to provide a qualitative score. An EO rank of H is provided for sites for which no observations have been made for more than 20 years. An X rank is utilized for sites that are known to be extirpated. Not all EO s have received such ranks in all states, and ranks are not necessarily consistent among states as yet.

### Appendix 3. Acknowledgments

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